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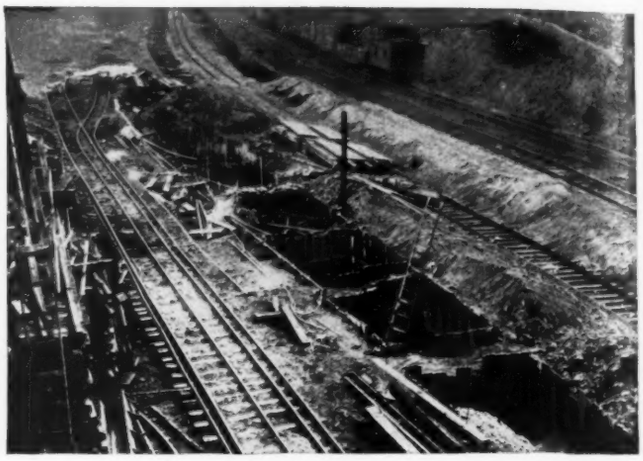

The new Lake Erie & Eastern R.R. recently built through the City of Youngstown, O., necessitated the erection of a high reinforced concrete viaduct 32 feet over tracks of the Erie, B. & O. and Pennsylvania R.R., on a long sharp angle, and along the banks of the Mahoning River, for a distance of 1,500 feet.

Test borings showed that the material on which the structure was built consisted of made ground and quick sand for a depth of 20 to 24 feet to bed rock. The net work of railroad tracks at this site required the building of five very thin, reinforced concrete walls, about 600 feet long, and with foundations built in such a manner between the tracks as not to interfere with railroad operation during construction. The foundations had to be carried down to bed rock, and built in a monolithic mass from the bottom to foundation offset.

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Engineering News

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Difficult Underpinning Along William St. Subway

By Edmund Astley Prentis, Jr.*

Engineers interested in subway construction will probably recall the interest aroused several years ago by the proposal of the Public Service Commission to build the William St. line in New York City and also the vigorous opposition to the proposed construction by the various property owners. The ground on which this opposition rested was that the height and weight of the buildings, as well as the well-known nature of the soil there, made the necessary underpinning "impossible" and that, were such construction attempted, disaster was sure to result. The Appellate Court, before which the case was eventually heard, decided, in spite of the adverse testimony of several well-known engineers and largely because of the opinion of Alfred Craven, the Chief Engineer of the Commission, that such construction was possible, but in view of the $40,000,000 in assessed property values involved only authorized the construction, provided the city assume primary responsibility for property damage. The contract, which provided for the construction of a two-track subway on William St. from Beekman St. to Old Slip, was awarded to Smith, Hauser & MacIsaac, Inc., who were just finishing a contract on the new Catskill Aqueduct in New York City. After one year's actual work the construction is 60% complete, and the underpinning, the original bone of contention, is practically completed.

FIG. 1. LOOKING DOWN WILLIAM ST., NEW YORK CITY, SHOWING UNDERPINNING FOR NEW SUBWAY

As can be seen from Fig. 1, which is reconstructed from a photograph taken from Maiden Lane looking south, William St. is a narrow, winding, hilly street through the skyscraper district. It is flanked on each side by all sorts of buildings, ranging from 4-story brick houses to 21-story steel structures, and nearly all rest on sand. The street is so narrow—only 40 ft. wide—that the subway for the greater part of its length extends from building line to building line, necessitating the removal in many cases of large portions of the original foundations. In general, the subgrade of the railroad is from 30 to 35 ft. below the curb and in the vicinity of the heaviest buildings about 15 ft. below their foundations and 10 ft. below water level. The soil on this part of William St. is the well-known Manhattan quicksand, a water-bearing mixture of fine-grained sand and clay, which gives a lot of trouble if not properly drained, but becomes compact and hard when the water is drawn off. The art of underpinning has been largely developed in New York City, particularly in connection with subway construction. The large amount of work has led to the development of new methods and the elimination to a large extent of the older methods of needling. Needling, in brief, consists of temporary beams, variously supported, that carry a building while the permanent underpinning is placed immediately below the columns and walls, and the needles are then removed.

The more modern methods simply reinforce the existing foundations with steel and concrete, so as to give

*Underpinning Engineer, Smith, Hauser & MacIsaac, Inc., 18 East 41st St., New York City.

the building a continuous foundation, and little by little place the permanent underpinning. This method gives a great deal of flexibility in the arrangement of the underpinning piers, and especially it gives a high degree of safety, the danger of collapse, with careful work, being much diminished.

Two Methods of Underpinning Used

There were two broad cases in the underpinning along William St.—one where the groundwater level was below the subgrade of the subway and the other where the sub-

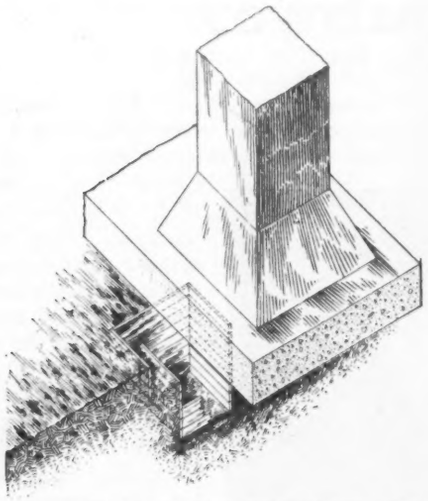


FIG. 2. METHOD OF SINKING PITS UNDER OLD PIERS

grade was below the groundwater level, the latter condition prevailing below John St., where most of the heavy buildings are. In either case the work preliminary to the actual placing of the underpinning—that is, the new masonry or other supports below the old foundations—was to reinforce the foundations with steel and concrete "grillages." These grillages consisted of I-beams, latticed girders or reinforcing rods fastened to the old foundations so that, when surrounded by concrete, a continuous mat or platform would be formed, below which the actual underpinning operations were conducted. This procedure is well illustrated by Fig. 3, which shows the method of tying the reinforcing I-beams to the base of a pier to be underpinned.

Below the grillages 4x4-ft. pits were excavated to groundwater level or subgrade. The pits were sunk practically without any lost ground, by means of horizontal sheeting, as illustrated in Fig. 2. When the pits were about 2 ft. below subgrade, they were concreted to within 15 to 18 in. of the old foundations or new grillage bottom and were carefully wedged with steel shapes and wrought-iron wedges, as may be seen in Fig. 4. The pits were started in groups for each building, in such a manner as to keep away from the column concentrations at the beginning and gradually to close together directly under the columns. Finally, a continuous, or semicontinuous, concrete wall 4 ft. thick would be formed of 4-ft. sections that directly supported the front wall of the building, acted as a perfectly secure cutoff to prevent loss of soil under the interior columns and also served as sheeting for the subway trench, requiring only bracing to the opposite wall.

Where groundwater level was encountered above subgrade, the second and much more difficult case was dealt with. Here, very strong grillages were constructed, and the pits, sunk to groundwater level, served as working spaces for driving steel piles and later as forms for the concrete incasing the tops of the piles, the steel columns and wedges between the piles and the building foundations. To better illustrate this method, the underpinning of the Bank of America will be described in detail.

Underpinning the Bank of America

This building, shown in Fig. 5, on the northwest corner of Wall and William St., is a heavy 9-story granite office building of the type built 30 years ago. The column loads average 500 tons, in great contrast to those of the 21-story Kuhn-Loeb Building across the street, which, though twice as high, has the same column loadings and is now being underpinned with the same general method about to be described. All the columns rest on pyramidal brick piers about 10x13 ft. at the bases. These in turn rest on an unreinforced-concrete slab about 2 ft. thick and 12 ft. wide, founded on a fine-grained sand and clay loaded to a little less than 3 tons per sq.ft. The building is well and solidly built. The subway at this point occupies the full width of the street—that is, from building line to building line—so that approximately 4 ft. of the old foundations for the full length of the building overhung the underpinning and, because of interference with the subway construction, had to be removed.

Subgrade is 32 ft. below the curb, 21 ft. below the bottom of the foundations and 14 ft. 6 in. below water level. These facts, together with the quality of the soil

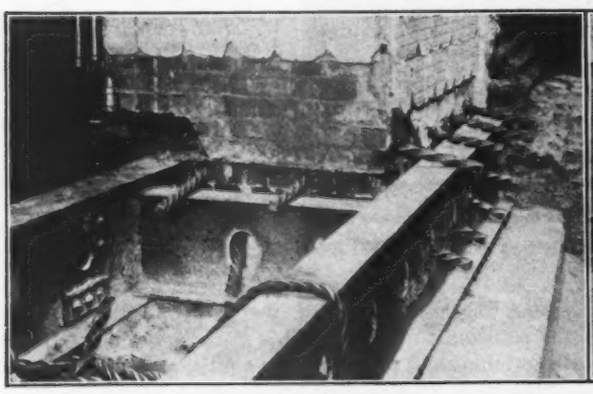


FIG. 3. METHOD OF TYING I-BEAM GRILLAGE TO OLD PIER FOOTING

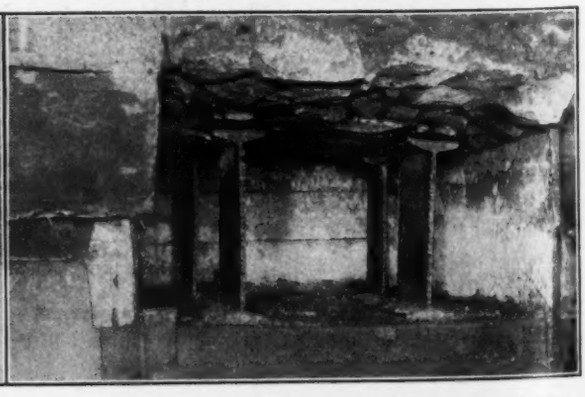


FIG. 4. VIEW OF WEDGES BETWEEN CONCRETE PIT AND BASE OF FOOTING

below water level (a true quicksand), made rather severe underpinning conditions.

The underpinning plan proposed by the contractor and approved by the Public Service Commission called for a double row of 14-in. steel and concrete piles directly wedged to the old foundations and extending from water level to a known stratum of hardpan and gravel about 8 ft. below subgrade. Each pile was to be tested to one and one-half times its assigned load (about 33 tons), and the steel shapes forming the wedging were to be incased in a continuous concrete wall from water level to the base of the foundations. It was stipulated that the centroid of the piles should coincide with the center lines of the columns, so as to do away with any eccentricity. The plan as proposed was substantially carried out, except that 10 piles more than were called for were driven as an extra precaution and the average pile load was reduced to 30 tons, but actually tested to 80 tons instead of 45 tons.

The first step was to reinforce the existing foundations by means of crisscrossed 15-in. I-beams, as shown in Fig. 7. Six such I-beams were placed between each pair of columns, in niches cut for them in the brickwork, and concreted in. In effect, they supported each column on a reinforced-concrete arch. Next, twenty-three 4-ft. spaces were marked out and consecutively numbered along the entire front of the building, and pit sinking was started. The pits between the columns were first sunk so as to serve as abutments for the concrete-steel arches mentioned, though only three or four pits were opened up at a time, care being taken not to dig under two adjacent columns at the same time until a large proportion of the underpinning had been completed. The following schedule gives the numbers of the pits as they were sunk, each set being completed before the next one was started. (For location of pits, see Fig. 7.)

Set Number	Pit Number	Set Number	Pit Number
1	4, 12, 20	4	1, 9, 17, 23
2	3, 8, 16, 21	5	5, 10, 14, 18
3	2, 7, 13, 22	6	6, 11, 15, 19

As every pit was practically identical with every other, except in minor details, only one will be described. An approach pit, 4x4 ft., was dug down to water level from the front of the building at the desired point underneath the foundation, so that the back of the pit was even with the neat line of the subway, or the building line of the building, as outlined in Fig. 2, the pit being carefully sheeted with finished 2x8-in. planking. This operation disturbed about 25 sq.ft. of bearing area, causing a loss in bearing capacity of the foundation of about 75 tons, this loss being compensated for immediately by a slight settlement of the building.

In the opening so made a temporary 14-in. steel pile, afterward filled with concrete, was driven to hardpan, about 25 ft. below the bottom of the pit. The location of this pile is shown dotted in the section of the pier and its underpinning at the right of Fig. 7. After it was tested to 80 tons and wedged up, the underpinning process continued farther back under the pier, as described hereinafter. The temporary pile was removed, when the underpinning was entirely completed, as it was in the subway excavation area.

The temporary and permanent piles are all of the same character. They consist of steel pipe sections 2 ft. long and 14 in. in diameter, made up of $^{7}/_{64}$-in. metal bent to the cylindrical shape with one vertical lap joint. One end of the pipe is made into a bell by a circumferential band of $^{7}/_{64}$-in. metal, 2 in. wide, riveted outside the pipe, and the other end is made a spigot by an interior band of metal, 4 in. wide, riveted so as to extend 2 in. beyond the end of the pipe. These piles are driven by a hydraulic ram, using the weight of the building as a reaction, in 2-ft. sections, each of which fits into the preceding one, the soil being mucked out from time to time so as to facilitate driving. When the desired depth is reached, the pile is carefully concreted by means of a bottom-dumping bucket or by first bailing the pile out and then dropping the concrete in. When the pile has been concreted, it is tested and wedged up.

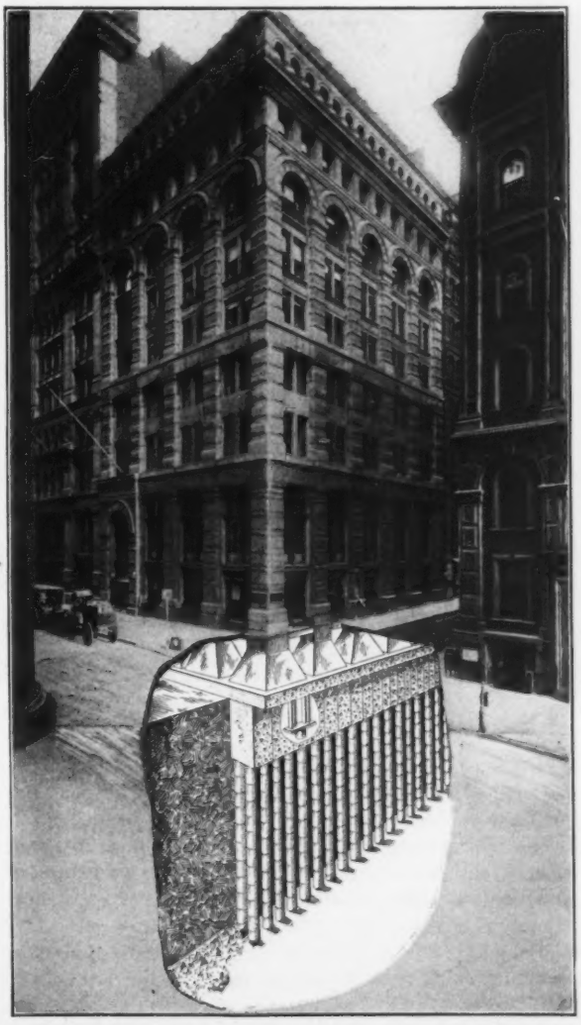


FIG. 5. BANK OF AMERICA, WALL AND WILLIAM ST., SHOWING METHOD OF UNDERPINNING

Wall St. running left background to right foreground, William St. running into right background

An inspection of the pile-settlement curve, reproduced as a part of Fig. 7, shows how a pile will repeatedly settle with successive applications of the load, but will hold if the load is not removed. The reason for this is that a bulb of compressed soil is formed at the base of the pile as the load is applied and as the pile settles; but this bulb is destroyed, or partly so, when the load is released, and to be reformed the pile has to settle. In order to overcome settlement of buildings previously observed and now

FIG. 6. VIEW UNDER BANK OF AMERICA DURING UNDERPINNING OPERATIONS

known to be due to the property just described, the following method of wedging, for which a patent is pending, has been devised:

The hydraulic pump, equipped with a pressure gage so that the hydraulic pressure can be seen at a glance, is connected to a 6-in. hydraulic ram that sits on a steel pile cap large enough to hold a 6-in. I-beam on each side of the ram, permitting its removal. The pile is jacked into the ground, more lengths being added to it as necessary, until 5,700 lb. per sq.in. on the gage shows that the pile is carrying a load of 80 tons. Two 6-in. I-beams are then cut the proper length and wedged with wrought-iron wedges from the cap to the bottom of the foundations, before the load is released. This wedging feature, as has been mentioned, has only been recently developed and in the firm's opinion is of vital importance and accounts for the very slight settlement that occurred

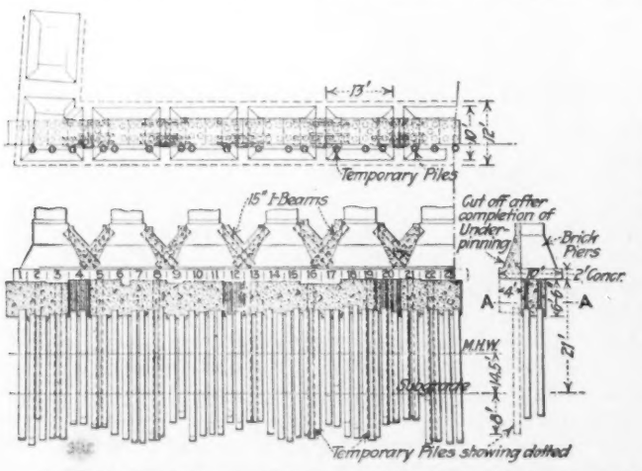


FIG. 7. DETAILS OF UNDERPINNING METHODS USED ON BANK OF AMERICA BUILDING

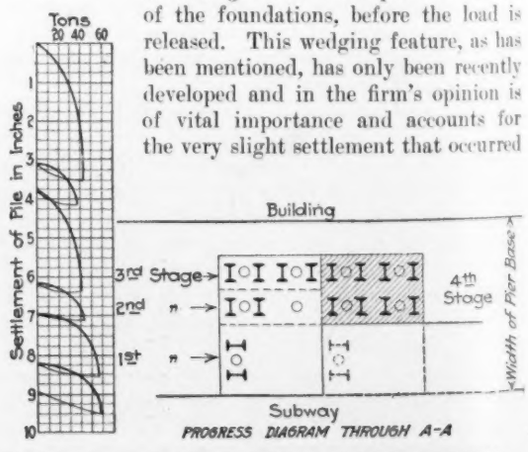


FIG. 8. SKETCH OF UNDERPINNING PROGRESS

in this building. This wedging immediately transmits about 40 tons, and sometimes 60 tons, to the pile, as we have often found out by means of the Sperry strain-gage.

The temporary pile wedged up in this manner makes up to a large extent the 75 tons lost in the pit sinking. The pit is then extended 2 ft. farther under the foundations, and two of the permanent piles are driven side by side in the manner just described. One of these piles is wedged up so as to make up for more of the lost bearing area of the foundation, the other being left unwedged until later, to give working room. The pit is again extended 2½ ft. and two more piles driven to hardpan. The progress of the process is indicated in the diagram in Fig. 8. The permanent piles are concreted and each in turn tested and wedged as already described. Then the remaining unwedged pile is wedged up, a concrete form built on the building line and the pit carefully concreted, an awkward operation in the narrow space available. The final contact between the concrete and the bottom of the building foundation is made with grout.

Fig. 6 shows part of the Bank of America at the last stage of the underpinning process. In the upper part of the view is one of the old brick piers, which has been braced with the crossed I-beams surrounded with concrete. Below is the continuous foundation slab and at the bottom are shown, beginning at the heavy timber upright at the left, a temporary pile wedged up to the foundation slab and next, at the right, a recess in which are four permanent piles and wedgings not yet surrounded with concrete. At the right and left hand of the recess, the piles have been completely incased in the final concrete, though the temporary piles and wedgings are still in place.

This series of operations was gone through for each pit until the building was completely underpinned. The temporary piles were then unwedged, the material being used elsewhere, and the overhanging 4 ft. of the old foundations was cut off. The building was absolutely unharmed, and the underpinning operations were carried on from outside the building without inconvenience to the owners, the tenants or the public.

Lazarus White is Managing Engineer for Smith, Hauser & MacIsaac, Inc., the immediate representatives of the Public Service Commission being John H. Madden and John F. Greathead.

Concreting Soft Spots in Railway Roadbed

To eliminate soft spots in a roadbed at points where drainage would be impracticable or unusually expensive, the use of a concrete mat or slab has been introduced by M. J. Connerton, roadmaster of the Queen & Crescent Route, under the supervision of Curtis Dougherty, Chief Engineer.

Owing to the great waste of time and material by section forces in maintaining line and surface over soft places (or what are commonly known as water pockets) and owing to the fact that in many cases the cost of draining with tile would be excessive, it was decided to try digging out the soft material and replacing it with concrete. The first attempt was made on mile No. 58, in November, 1911. After providing the material for the concrete, the supervisor was instructed to do the work with the section force, putting out slow orders.

The ballast was removed from between the ties. The track was shifted 2½ ft. to the opposite side from where the concrete was to be put in and tamped and lined on its temporary location, so that trains could safely pass over it at 15 mi. per hr. The excavation was then made. The soft place was about 40 ft. long and appeared on only one side of the track. Therefore, the excavation consisted of a trench 3 ft. wide, 3 ft. deep and 40 ft. long, with its center located along the outer edge of the base of the rail.

As the excavation progressed, a portion of the gang started to mix the concrete and place it in the trench; and the work was continued in this manner until the entire trench was excavated and filled with 2 ft. of concrete. About 1 ft. of ballast was placed over this concrete, or up to the bottom of the ties. The subgrade along the concrete slab was leveled and a 12x12-in. sill laid outside of the concrete for the entire length of 40 ft.

The track was then shifted back to its permanent line, and bridge ties were placed with one end resting on the 12x12-in. sills. After the track and sills had been tamped, the lining and filling were done, and the track was left for about two weeks in order to give the concrete sufficient time to set. The slow signals were kept out during this period. When the concrete became sufficiently hard, the bridge ties and sills were removed, the track was put in good condition and in a few days trains were allowed to run without restriction as to speed.

The trouble at this point entirely disappeared, and no extra work has been done on it since. In fact, it is difficult to locate the place, as it shows no unusual appearance. The concrete was made with bank gravel and mixed 1:5. The reinforcing consisted of ⅞-in. rods, three being placed near the bottom and three near the top of the concrete. The cost of labor and material was as follows:

1 foreman 1¼ days @ $62.50 per month...	$2.60	
10 laborers 1¼ days @ $1.45.....	18.12	
		$20.72
Cement	$15.19	
Gravel	4.50	
Reinforcing	15.60	
		35.29
Total		$56.01

This soft place was in a cut on a heavy grade. To drain it would have required about 300 ft. of tile, 33% of this being in hardpan and shale rock, which would have had to be drilled and blasted. The cost of laying this tile 5 ft. below the subgrade and reshaping the subgrade and ditch was estimated at 60c. per foot, or $180, indicating a net saving of $124 in favor of the concrete slab.

The results were so satisfactory that the method has been applied at about 25 other places, varying in length from 15 to 60 ft. In no case has the concrete shown signs of failure. In one case it was applied two years ago at a place that was very troublesome. The track has been tamped only once in the two years, and even after the recent severe winter the track at this point does not show signs of needing repairs.

The method of working has been changed for the later jobs. Instead of throwing the track, some bridge ties and mud sills are placed under it and firmly tamped, putting it in good condition before excavation is commenced. The usual slow signal is placed, and then the men proceed with the work. This practice is more satisfactory and economical and involves less train delay.

California Rainfall and Runoff and Recent Floods

By M. J. Bartell and R. P. McIntosh*

SYNOPSIS—A general review of rainfall and runoff in California and a special study of the two floods in January, 1916.

Recent destructive floods in southern California have claimed the attention of engineers, particularly those interested in flood control and in water-supply development. These floods are of especial interest in that they give additional data upon which to base spillway estimates and estimates of probable maximum discharge in the matter of flood control. The prime interest centers upon the question as to what was the intensity of these floods as compared to previous floods in the same locality and elsewhere in the state. The data are not yet at hand to permit a complete analysis, but there is sufficient information for a very general treatment of the subject.

Hydrographic conditions in California cover a wide range—from the desert regions of eastern and southeastern California, where the rainfall is almost negligible, to regions in the northern districts with average seasonal rainfall of about 100 in. As distinguished from the central and eastern part of the United States, the rainfall in California is confined to about a 100-day period from December to March inclusive.

The precipitation during the remainder of the year is relatively small and is rarely more than 5% of the seasonal total. In the Coast Range the snowfall is light, and it has a negligible effect in retarding the runoff that occurs during the rainfall period. In the San Francisco Bay region and north the average annual rainfall ranges from about 15 in. to nearly 90 in. This gradually decreases to the south, where in the San Diego and Los Angeles sections it varies from 8 or 9 to somewhat over 20 in. In the San Joaquin and Sacramento Valleys, lying between the Coast Range and the Sierra Nevada Mountains, the average seasonal rainfall varies from 5 to 30 in., increasing from south to north. On the westerly slope of the Sierra Nevada Mountains, lying immediately east of these valleys, the precipitation increases with elevation, the rate varying from 0.05 to 0.09 in. per 100-ft. rise. The maximum varies from some 30 or 40 in. in the region east of Fresno to almost 90 in. in the region east of Chico. The maximum precipitation occurs on the westerly slope at a point from 2,000 to 6,000 ft. below the crest, beyond which point it very gradually decreases to 10 in. or less at the foot of the easterly slope and beyond. In the upper reaches of the Sierras during the winter months the precipitation occurs as snow, which runs off during the spring and summer months. For the Sierras the mean seasonal runoff varies from 20 to over 50 in.; for the Coast Range, from 10 to over 50 in., in both cases increasing in intensity from south to north. In the region of the recent floods—San Diego and Los Angeles—the mean seasonal runoff varies from less than one to over 10 in., the runoff period being comparatively short, generally less than 60 days.

*Hydraulic Engineers, Hetch Hetchy Department, City Engineer's office, San Francisco, Calif.

At or near the summit of the Sierras is found the region of greatest snowfall in the United States. In seasons of normal precipitation hundreds of square miles of this region are covered with from 10 to 15 and 20 ft. of snow so packed as to yield about 30% of its volume of water.

The snowfall for the month of January, 1916, was considerably above normal, but the total accumulated amount has been exceeded, as shown by Table 1, from "Climatological Data California, 1916."

TABLE 1. HIGH SIERRA SNOWFALL: INCHES ON GROUND, JAN. 31

	Fordyce Dam	Summit	Tamarack
1907	94	148	180
1908	68	87	104
1909	107	172	190
1910	67	68	106
1911	124	218	310
1912	59	41	55
1913	78	88	118
1914	107	192	274
1915	67	80	116
1916	161	215	293

For the Coast Range region north of Los Angeles the runoff was heavy, but no floods of unusual intensity have been reported. In the Sierras, while the snowfall was heavy, the runoff was not extraordinary. Of interest in this connection there follows a brief review of exceptional floods in California, taken from United States Geological Survey publications and advance information from H. D. McGlashan, District Hydrographer:

The floods of 1904 in the Sacramento Valley were very destructive and were considered at that time to be as large as, or larger than, any flood previously known, with the possible exception of those occurring in 1862, of which no records were available. A commission of hydraulic engineers was appointed in 1904 to investigate the flood-control situation of the Sacramento Valley and recommended that provision be made for handling 250,000 sec.-ft. in the lower region of the Sacramento River.

In March, 1907, just three years after the commission made its recommendation, an unprecedented flood occurred throughout the entire Sacramento Valley, reaching a calculated maximum of 640,000 sec.-ft. The rates of flow of some of the tributaries of the Sacramento River, together with other drainage areas, are given in Table 2.

Measurements made under the direction of the Los Angeles Flood Control Commission on the headwaters of the streams in the vicinity of Los Angeles showed rates of runoff from 100 to 700 sec.-ft. per sq.mi., the drainage areas varying from less than 10 to about 50 sq.mi. These rates are for the region of greatest slope of drainage and highest rainfall.

Table 3 gives a comparison between the maximum mean daily and the rate of greatest flow during the highest stage for the same day.

The comparative data are too meager to permit a general deduction, but, as a rough rule, it is thought that for Sierra streams 120% of mean daily maximum would give approximately the maximum rate of flow and for the Coast Range streams about 150% would give fairly accurate results.

In the consideration of the rates of flow from Sierra streams it must be borne in mind that much of the precipitation in the higher areas occurs as snow and, therefore, the actual area contributing runoff is less than the total area used, so that the rate of runoff is somewhat higher than that previously given.

TABLE 2. MAXIMUM RATES OF FLOW FOR CALIFORNIA STREAMS

(From Records of United States Geological Survey—H. D. McGlashan)

Stream	Drainage Area, Sq.Mi.	Maximum Runoff, Sec.-Ft. per Sq.Mi.; Mean for 24 Hr. 1907	1909	1911	1913	1914	1916
Sierra Nevada Mountains							
Feather River at Oroville	3,640	51.4	38.0	21.0	...	...	...
Yuba River at Smartsville	1,220	82.0	91.0	32.0	...	...	...
Bear River at Van Trent	263	106.5	113.0*	85.0	...	...	...
American River at Fair Oaks	1,910	62.2*	51.3	36.0	...	...	...
Consumne River at Michigan Bar	524	62.2	38.2	42.0	...	...	...
Calaveras River at Jenny Lind	395	104.0	83.5	176.0	...	...	...
Stanislaus at Knights Ferry	935	58.1	39.4	64.2*	...	...	...
Tuolumne River at La Grange	1,500	34.5	17.8	40.4*	...	...	...
Coast Range							
Puta Creek near Winters	805	39.1	35.8	35.0	74.5	...	...
Stony Creek near Fruto	601	41.6	28.3	25.7	...	...	...
Arroyo Seco near Soledad	215	42.6	28.6	62.0	...	81.5	...
Lower California							
San Diego River at Lakeside	208	5.0	12.2	3.1	...	9.6	...
San Luis Rey River near Mesa Grande	208	...	...	...	...	16.7	...
San Luis Rey River near Pala	318	9.0	10.1	3.5	...	21.0	...
San Gabriel near Azusa	222	...	32.3	41.1	...	82.0	...
Santa Ynez near Lompoc	725	...	48.2*†	28.3	...	57.7	...
San Luis Rey at Oceanside	534	...	...	...	...	...	135*‡
Sweetwater River at Sweetwater dam	186	...	...	...	...	...	177*§
San Diego River, San Diego	434	...	...	...	...	...	69*§
Santa Ana River near Mentone	182	...	...	10.1	...	46.7	...

*Highest short-time mean. †Calculated by writers from gage heights. ‡Record by C. H. Lee. §From R. N. Hamlin.

TABLE 3. MAXIMUM MEAN DAILY FLOW AND HIGHEST RIVER STAGE

Stream	Drainage Area	Maximum Rate of Flow, Sec.-Ft. per Sq.Mi. 24-Hr. Mean	Highest Stage	% Highest Stage to 24-Hr. Mean
Bear River at Van Trent	263.0	96.5	113.0	117
American River at Fair Oaks	1,910.0	55.0	62.2	113
American River	195.8	30.0	32.6	109
Consumne River	157.9	86.1	107.0	124
Stanislaus River at Knights Ferry	935.0	39.5	64.2	162
Tuolumne River at La Grange	1,500.0	35.0	40.4	116
Santa Ynez River near Lompoc	725.0	24.1	48.2	200

As a general rule, the valley or low-land channels of Coast Range streams of California are rarely capable of carrying more than one-half their maximum flood discharge. As a consequence, the overflow of the normal channels is quite frequent. It is only when exceptional damage results that public attention is directed to the fact.

Except in fairly dry years large areas are inundated in the San Francisco Bay district, the Livermore Valley, the Salinas Valley and elsewhere in the coast Range region, but the damage resulting is generally small, owing to the fact that the flooded areas are usually quite large and the stream cones flat, permitting the excess waters to seek relief in all directions.

In southern California the effect of the débris cones on floods is very important. The quantity of solid material carried is exceptionally large, and the channels of the streams are usually choked up at and near the mouths of the cañons, where the streams debouch upon the plains. The cones are comparatively steep, and the flood waters rush over them with considerable velocity, eroding new channels, destroying large areas of valuable and fertile farming lands and leaving barren areas of sand, gravel, etc.

The great fertility and high value of the old river-bottom lands in many cases have caused the agriculturist to encroach with his cultivation close up to the present stream channels. Consequently, any flood that causes a channel change of even a comparatively small amount results in great damage. The channels of some of the streams have been known to shift several miles during one flood. This is especially true in the neighborhood of Los Angeles, where the flood plains are of much greater extent than in the region around San Diego.

The rainfall for the month of January, 1916, was exceptionally large; and as practically all of it was concentrated in a period of 10 days, distastrous floods resulted, especially in San Diego County. The damage directly around Los Angeles was not so great as during the floods of February, 1914. The rainfall for the two storm periods in January, 1916, is given in Table 4.

TABLE 4. RAINFALL IN INCHES AT TYPICAL STATIONS IN SOUTHERN CALIFORNIA DURING THE FLOODS OF JANUARY, 1916

Station	Jan. 14-19	Jan. 25-28	Highest Daily, 24 Hr.	Total, Jan.	Mean Annual*
Aguanga	9.48	7.0†	Jan. 27— 5.0	17.85	....
Azusa	12.14	4.10	Jan. 17— 6.10	20.32	17.86
Beaumont	8.49	5.03	Jan. 27— 2.70	16.16	....
Campo	12.93	6.73	Jan. 16— 4.75	20.44	20.15
Claremont	10.38	4.16	Jan. 17— 4.68	18.37	17.07
Corona	8.28	5.62	Jan. 27— 5.0	17.12	....
Cuyamaca	17.96	13.0	Jan. 27— 8.54	36.50	39.26
El Cajon	9.09	6.65	Jan. 27— 5.60	16.68	12.49
Elsinore	8.20	5.08	Jan. 16— 3.43	14.83	....
Escondido	10.74	6.90	Jan. 27— 5.53	19.55	14.56
Los Angeles	6.90	2.94	Jan. 17— 4.16	13.30	17.30
Lowe Observatory	11.40	3.76	.....	19.86	26.49
Mesa Grande	16.90	11.71	Jan. 27— 8.55	33.28	....
Nellie	23.54	15.25	Jan. 17—11.24	44.41	....
Oceanside	5.24	3.76	Jan. 26— 2.62	10.90	....
Pomona	9.95	4.27	Jan. 18— 4.85	18.74	....
Redlands	5.84	3.26	Jan. 17— 3.44	10.64	14.96
Rialto	21.17	8.26	Jan. 17—12.95	39.76	....
San Bernardino	8.75	4.04	Jan. 17— 5.29	15.51	15.97
San Diego	4.23	2.68	Jan. 27— 2.19	7.56	10.51
San Jacinto	5.88	3.18	Jan. 17— 2.78	10.71	12.65
Seven Oaks	16.32	9.80	Jan. 27— 6.45	31.10	....
Sierra Madre	10.21	3.92	Jan. 17— 5.50	18.74	23.77
Squirrel Junction	27.80	9.14	Jan. 17—16.81	50.29	....
Warner Springs	11.31	5.48	Jan. 17— 5.08	18.92	....

*Where no "mean annual" is given, the record is either too short or broken to determine the mean. †Jan. 27-28.

TABLE 5. HEAVY RAINFALL IN CALIFORNIA PREVIOUS TO 1916

Station	Year	Date	Rainfall, In.
Campo	1891	August (24 hr.)	16.10
Cuyamaca	1891	Feb. 22-23 (48 hr.)	22.40
Bear Valley dam	1891	Feb. 22-23 (48 hr.)	28.00
Mono Ranch	1906	Mar. 12 (24 hr.)	11.50
Onskip	1907	Mar. 17-19 (3 days)	21.88
Sterling City	1907	Mar. 17-19 (3 days)	20.72
Helen Mine	1909	Jan. 14-16 (3 days)	21.50
Dear Creek	1909	Jan. 13-15 (3 days)	20.27
La Porte	1909	Jan. 13-15 (3 days)	20.46
Magalia	1909	Jan. 13-15 (3 days)	20.38
Pilot Creek	1909	Jan. 13-15 (3 days)	20.28

It is seen from Tables 4 and 5 that the rainfall during the month of January, 1916, was very abnormal for the southern part of California; in several instances the monthly precipitation is greater than the mean annual.

A study of the rainfall records shows that there were two distinct and heavy storm periods, the first of which caused comparatively little damage, owing to the fact that the lands and stream channels were more or less dry and consequently absorbed large quantities of water.

The second storm (which followed the first within a few days) fell upon areas already saturated. As a result, unusually heavy runoffs occurred and caused a great deal

of damage. In San Diego County, the San Diego, San Luis Rey and Sweetwater Rivers and others gave greater discharges than had ever before been recorded. It was from the effects of this second storm that the Lower Otay dam went out.

C. H. Lee, hydraulic engineer, had current-meter measurements made of the San Luis Rey River at Oceanside on Jan. 27, 1916. These showed a maximum discharge of 72,000 sec.-ft. from a drainage area of 534 sq.mi., or 135 sec.-ft. per sq.mi. The San Diego River at San Diego showed a discharge (estimated from gage height and previous records of floods) of 30,000 sec.-ft., and the Sweetwater River at Sweetwater dam was estimated at 33,000 sec.-ft. from a drainage area of 186 sq.mi., giving a runoff of 177 sec.-ft. per sq.mi. This discharge is based on an approximate estimate and appears to be abnormally high, but it should be remembered that the drainage area (which is small and quite mountainous) was thoroughly saturated at the time of the second heavy rain (Jan. 27), and conditions were extremely favorable for a high rate of runoff. There have also been records of runoff from this area of 100 sec.-ft. per sq.mi. during previous years, when the rates of rainfall and distribution of the storms were not nearly so favorable for high percentages of runoff. This rate of runoff compares favorably with the rates obtained by the Los Angeles Flood Control Commission.

Water-Works Construction in Winter at Hibbing, Minn.

By R. E. McDonnell*

Hibbing is the largest incorporated village in the world—population, 12,000. Owing to the valuable iron-ore deposits beneath the site, its assessed valuation is approximately $80,000,000, making it the richest village in the world.

The old water-supply became contaminated by the mining operations, and the water level was lowered because of the draining of the iron mines. The new supply is procured from a series of eight 30- and 36-in. wells, sunk from 50 to 125 ft. into the glacial drift. These wells are from ½ to 1½ mi. apart. Each is housed in (Fig. 1) and provided with a motor-driven Layne centrifugal pump. The wells are cased with Layne patent shutter screens and are of such diameter as to permit large-capacity pumps being placed directly in the wells. One of the wells in a continuous 17-day test yielded 1,000,000 gal. in 24 hr.

The water from each well is pumped to a centrally located reinforced-concrete reservoir of 1,000,000-gal. capacity, shown under construction in Fig. 1. Adjoining the collecting reservoir is a main power house of brick and concrete with tile roof, in which are located four electrically operated pumps that force the water from the collecting reservoir through approximately 6 mi. of 18-in. main to a 300,000-gal. elevated steel tank located in the village.

FIG. 2. PUMP HOUSE AND DERRICK WELL NO. 2

For each of the eight well pumps there is a remote-control electrically operated device that starts and stops the pumps, so that the wells may be pumped all at one time or individually. The centrifugal well pumps have, under test, showed an efficiency as high as 72%. The high-duty pumps in the main power house have a higher efficiency and have a total capacity of 5,500,000 gal. per 24 hr. These pumps are of Platt Iron Works manufacture, with Westinghouse motors.

Since construction work began, the variation in temperature has been from +100° in the shade to −54°, the low record having been obtained in January, 1916. The discharge lines into the village are being laid at a depth of 10 ft., to insure against freezing.

In spite of the severe winter weather the construction work progressed without interruption during the winter of 1914-15; and it was found that the freezing weather added greatly to the economy of construction, as the ground was sufficiently frozen to prevent a caving of the deep trenches in which the discharge lines were laid. The country adjoining the pipe line was at one time heavily timbered and has been logged off and burned over, leaving a large number of partly burned logs along the road. In the evening these logs were hauled and scat-

*Of Burns & McDonnell, Consulting Engineers, Interstate Building, Kansas City, Mo.

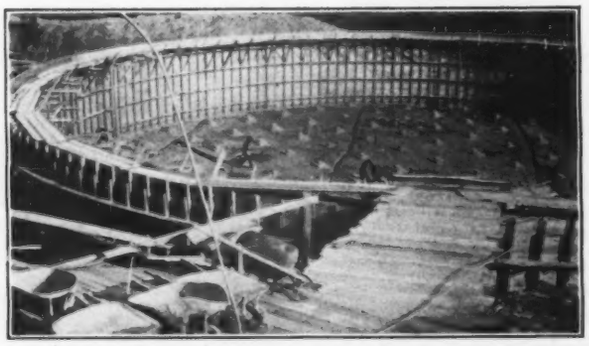


FIG. 1. CONSTRUCTING COVERED RESERVOIR
The forms for the concrete wall and the scaffold for wheeling up the concrete are completed

tered along the line of the proposed pipe-trench excavation. The burning of the logs during the night sufficiently thawed out the ground so that a steam shovel could remove the top soil. The remaining earth was frozen just enough to prevent any difficulty from water or caving. This condition made the excavation much easier than it would have been had the pipe lines been excavated during the summer season when the soil was saturated with ground water. Almost all the pipe lines were excavated by the aid of steam shovel (Fig. 3). Excavation for the 1,000,000-gal. reinforced-concrete reservoir was likewise handled with steam shovel.

A Daily Supply of 3,000,000 Gal. or No Pay

The contractor guaranteed to deliver a total of 3,000,000 gal. of water per 24 hr. Failing to secure this volume of water, the village was to be at no expense whatever. Another guarantee feature was that the water was to be secured at a location free from mine drainage and that the character of the water was to meet the approval of the state Board of Health, which made frequent analyses as the work progressed. Another feature of the guarantee was an important one in the development of well supplies—that is, the avoiding of drawing down the water plane between certain limits. This is accomplished by scattering the wells and by pumping from them intermittently at various locations, thus maintaining a uniform water plane over the entire collecting area of about 9 sq.mi. The contractor, before entering into the guarantee, made his own tests, determining the formation and geological conditions. From the eight wells completed, tests show that approximately twice the guaranteed volume of water has been secured.

The elevated steel tower (Fig. 4) was erected during the winter months with scarcely any lost time. The subcontractor was the American Bridge Co., Minneapolis, Minn.

The entire installation has progressed with scarcely any interruption, although located close to the Canadian line and at a place where a few years ago it would have been thought folly to carry on work throughout the winter months.

All the water is delivered to the discharge mains through a venturi meter. The pumps are electrically operated, a separate panel and switchboard being arranged for each well pump. The four high-duty pumps are so arranged that they can be operated in series, giving direct fire pressure when needed. The steel tower and tank have an electrically operated cutoff valve controlled from the main station. The power house is equipped with a hot-water heating plant, shower baths and lockers, and the whole building is of fireproof construction. An overhead crane is provided for handling machinery and equipment.

The cost of the improvement was approximately $500,000, which was met by village warrants. Only 18 months' actual construction time was required for the completion of the work. The general contractor for the entire installation was the Layne & Bowler Co., Houston, Tex. The works were designed and supervised by Burns & McDonnell, consulting engineers, Kansas City, Mo., with R. J. Morehouse at Hibbing as resident engineer.

FIG. 3. STEAM-SHOVEL TRENCHING FOR WATER MAIN

FIG. 4. STEEL WATER TANK, HIBBING, MINN.
300,000-gal. capacity; hemispherical bottom; on 120-ft. tower. Erected in winter

All Municipally Owned Public Utilities in New Jersey would be placed as fully under the control of the Public Utility Commission as are privately owned utilities, if the legislature should pass Senate Bill No. 98. This bill amends Paragraph 15 of Chapter 195 of the laws of 1911, except as regards cities of the first class. The utilities mentioned in the paragraph named include "any steam railroad, street railway, traction railway, canal, express, subway, pipe-line, gas, electric-light, heat, power, water, oil, sewer, telephone, telegraph system, plant or equipment for public use." The amendment provides that "no such plant or system shall be constructed or acquired by any public utility unless and until the Board of Public Utility Commissioners, after hearing upon notice, shall determine and certify that such system or plant is necessary or proper for the public convenience. From the language quoted it appears that, should the act pass, neither sewerage nor water-works systems could be constructed in New Jersey without the approval of the commission named. It is already necessary to secure approval from the State Department of Health.

Reconstruction of Mississippi River Bridge at Keokuk

SYNOPSIS—The old single-deck spans are being replaced with double-deck spans having a railway track below and highway and sidewalk above. The reconstruction is of special interest in that the bridge has to be kept open for railway and roadway traffic during the progress of the work.

The reconstruction of the long steel bridge crossing the Mississippi River at Keokuk, Iowa, by placing a new superstructure on the old piers, is complicated by the necessity of keeping the bridge open for railway, street-railway, team and pedestrian traffic.

The bridge has a 380-ft. swing span, two fixed spans of 254½ ft. and eight fixed spans of 149 to 162 ft. The old bridge had a single lower deck for all traffic, teams being excluded while trains were crossing, as there was not room for them to pass. The new bridge has a lower deck, with single track for steam and electric-railway service, and an upper deck, with 18-ft. roadway and a 4½-ft. walk (on the south side only) carried by cantilever brackets. The approaches for the upper deck are 600 ft. long on the Keokuk side and 360 ft. on the Hamilton side. The new bridge was described in *Engineering News*, Aug. 5, 1915. Fig. 1 shows the condition of the work on Dec. 1, 1915.

FIG. 1. RECONSTRUCTION OF MISSISSIPPI RIVER BRIDGE AT KEOKUK, IOWA (DEC. 1, 1915)

Five of the new 160-ft. double-deck spans at the east end have been erected. The locomotive crane is standing on the falsework of the sixth span, and the seventh span is partly dismantled. The next short span and the two 254-ft. spans have the old trusses still in place. The drawspan is next to the long span at the right

Alterations to Piers

The piers are of stone masonry, resting on the bedrock that forms the river bottom. Owing to the greater depth of the floor system of the new bridge, with tracks at the original level, the tops of the piers were cut down about 5 ft. and capped with reinforced concrete. This work was done during the erection of the steel, the new shoes being suspended from the trusses (on falsework) just clear of their final elevation and lowered to a bearing as soon as the concrete had set.

A small concrete mixer was run out on the bridge, and the concrete was spouted through the floor. As the trusses of the new bridge are spaced 16 ft. 7 in. c. to c. while those of the old one were spaced 21 ft. 6 in., there was plenty of room to place the mixer on a platform over the end of the pier, the old outside walks having been torn up. One pier is in bad condition and will be rebuilt from above the low-water line. Until the completion of this work, the ends of the spans to be carried by this pier will remain supported on the falsework.

The river bottom is limestone bedrock, with little or no cover, so that no piling can be used. The falsework consists of 6-post bents carrying the working platform. In placing the bents each post was driven to a firm bearing on the rock and then cut off at the proper elevation for the cap.

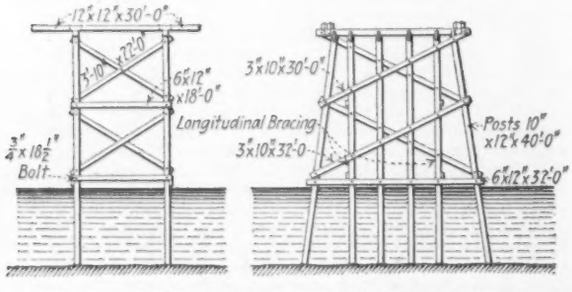


FIG. 2. FALSEWORK TOWERS FOR THE 380-FT. DRAW SPAN

For the shorter fixed spans—149 to 162 ft.—each span had 7 bents connected by longitudinal struts, with diagonal bracing connecting one pair of bents at each end. This construction is shown in Fig. 3. Each of the two longer spans—254 ft.—had 12 bents, with the end bents parallel with the piers and the others at right angles to the bridge. These were spaced about 23½ ft. apart and braced together in pairs to form five braced towers under each span (Fig. 4).

For the drawspan a different arrangement was used (Figs. 2 and 4), owing to the swift current in the navigable channel and the desirability of leaving ample passageway for drifting ice. This precaution is specially necessary in view of the fact that the falsework simply rests on the river bed, so that pressure against it is to be avoided. Under each arm of this span there are 8 bents, braced in pairs to form 16-ft. towers spaced 25 to 28 ft. apart. The longitudinal bracing of the towers is in the plane of the outer vertical posts, as shown in Fig. 2.

In all falsework bents the posts are 10x12 in., the outer posts being battered. The caps are 12x12-in., 28 ft. long, not driftbolted, but secured by splices bolted to the sides of the cap and posts. Along the ends of the caps are stringpieces 12x12 in. The sway-bracing of the bents is of 3x10-in. planks, and the tower struts 6x12 in.

Falsework was built for three spans at a time. As soon as that for the first span was completed, work on the steel was commenced, while at the same time the falsework was being put in under the next span. In each of the eight shorter spans plate-girder stringers for the 254-ft. spans were used as falsework stringers, braced by horizontal and diagonal transverse timbers. The same arrangement was used for one of the longer spans, while for the other there were six lines of the old trussed floor-beams to serve as stringers. For the drawspan falsework the towers had four lines of 15-in. I-beams, from the approach, while between the towers were six of the old floor-beams.

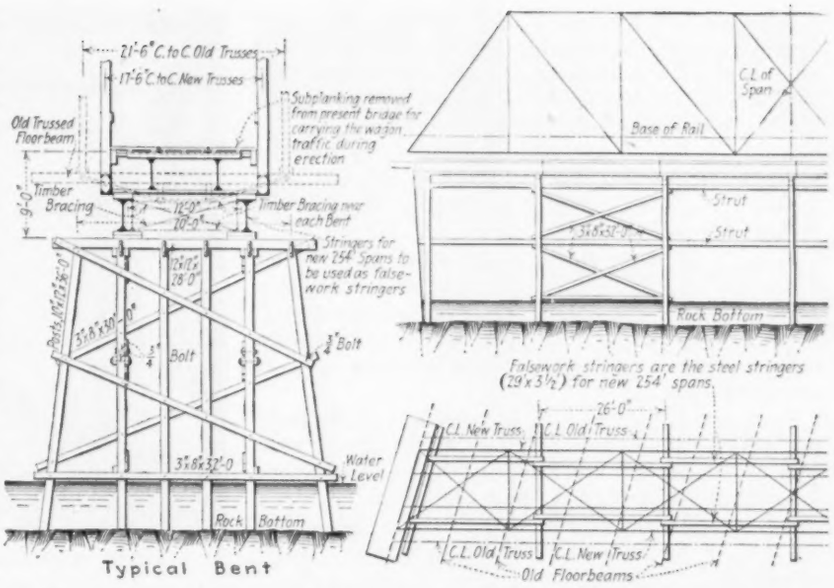

21'-6" C. to C. Old Trusses
17'-6" C. to C. New Trusses
Subplanking removed from present bridge for carrying the wagon traffic during erection
Old Trussed Floor beam
Timber Bracing
Timber Bracing near each Bent
Stringers for new 254' Spans to be used as falsework stringers
Bolt
Rock Bottom
Water Level
Typical Bent
C.L. of Span
Base of Rail
Strut
Rock Bottom
Falsework stringers are the steel stringers (29"x3½") for new 254' spans.
C.L. New Truss
C.L. Old Truss
Old Floorbeams

FIG. 3. FALSEWORK AND METHOD OF ERECTION FOR THE 160-FT. SPANS

With the falsework in place the first work was the renewal of the floor system. The old floor construction consisted of trussed floor-beams spaced about 12 ft. c. to c. and carrying wooden stringers to which the deck planking was spiked. The rails rested directly upon two of these stringers. The two sidewalks, outside of the trusses, were carried by extensions of the floor-beams.

The new steel stringers, mentioned before as being used for falsework, are placed in elevation somewhat below the new floor-beams, and the old stringers are supported on them. The old trusses and overhead bracing are then dismantled. The old floor, consisting of paving, subplanking and ties, is left until all the spans are erected.

In erecting the new floor system slots are first cut crosswise in the floor, to allow the new floor-beams to be slipped in place; then the old wooden stringers are removed and the new steel stringers inserted under the old ties. This work is done piecemeal, or panel by panel, the floor-beams and stringers being removed as the replacement work reaches them.

When all the spans are erected and the roadway on the upper deck is finished, the team traffic will be diverted to this roadway. In the intervals between trains the old deck will be torn up and replaced with an ordinary railway deck with rails and guard timbers on crossties.

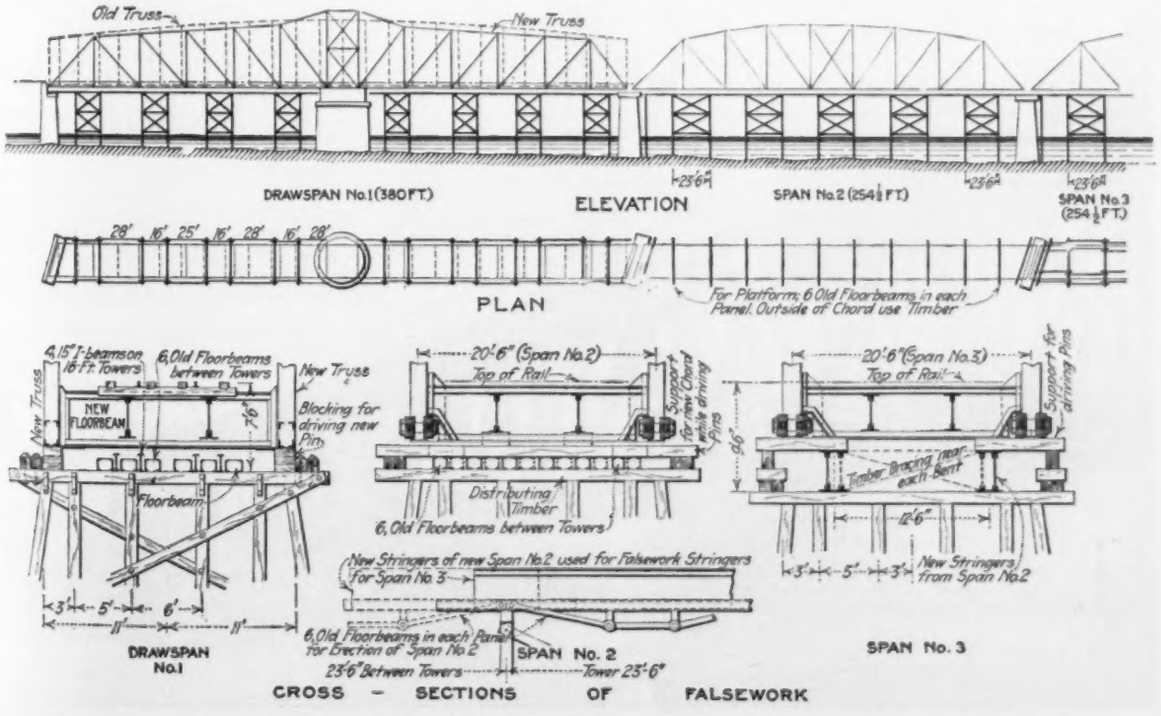

Old Truss
New Truss
DRAWSPAN No.1 (380 FT.)
ELEVATION
SPAN No.2 (254½ FT.)
SPAN No.3 (254½ FT.)
PLAN
For Platforms; 6 Old Floorbeams in each Panel. Outside of Chord use Timber
4-15" I-beams on 16 Ft. Towers
6 Old Floorbeams between Towers
NEW FLOORBEAM
Blocking for driving new Pin
Floorbeam
20'-6" (Span No.2)
Top of Rail
Distributing Timber
6 Old Floorbeams between Towers
Support for new Chord while driving Pins
20'-6" (Span No.3)
Timber Bracing near each Bent
12'-6"
New Stringers from Span No.2
New Stringers of new Span No.2 used for Falsework Stringers for Span No.3
6 Old Floorbeams in each Panel for Erection of Span No.2
23'-6" Between Towers
Tower 23'-6"
DRAWSPAN No.1
SPAN No. 2
SPAN No. 3
CROSS - SECTIONS OF FALSEWORK

FIG. 4. FALSEWORK AND PLATFORMS FOR THE 380-FT. DRAWSPAN AND TWO 254½-FT. FIXED SPANS

After the completion of the falsework the old trusses were dismantled, commencing with the span at the east end. This work was done with a 25-ton four-wheel locomotive crane standing upon the railway track (Fig. 1). The material was loaded upon flat-cars that were handled by a dinkey locomotive. The steel for the new trusses was delivered and erected in the same way, the posts being riveted to the floor-beams already in place. The material yard is at the east end of the bridge.

In the two longer spans, with eye-bar members for the bottom chords, blocking was built up on the falsework to support the ends of the chord members while the pins were driven. The entire span was riveted up complete upon the falsework, which was then removed to another span.

Fig. 5 is a view of the work in progress. In the background is a train on one of the new spans. An old span is in the foreground, and between this and the new one is a dismantled span with track carried on falsework. The brackets extending out to the right on top of the new span are for the sidewalk on the upper deck. These are also shown in Fig. 6.

Handling Traffic Over the Bridge

While there are not many steam trains crossing the bridge, there is a half-hourly service of electric cars. To provide for their passage, the contractors remove the locomotive crane to a siding at the material yard and clear the bridge every half-hour. The cars and any waiting teams then cross, first in one direction and then in the other. This arrangement involves a delay averaging 10 min. from the time of stopping work until its resumption. As electric wires cannot be maintained across the bridge, the cars are hauled across the bridge by the contractor's dinkey locomotive.

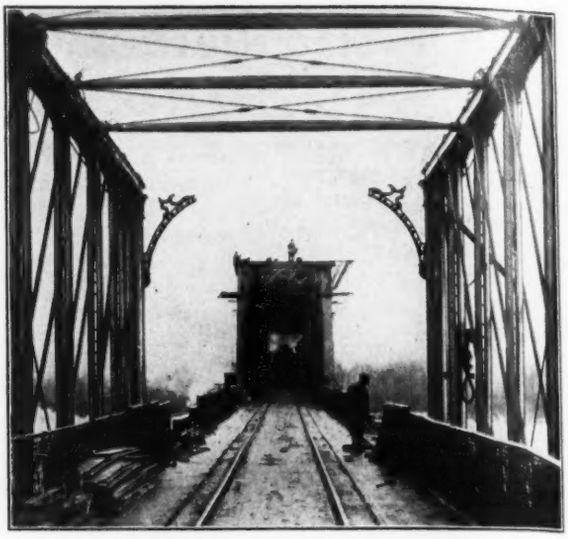


FIG. 5. DISMANTLING ONE OF THE SPANS

The work of renewing the first span was commenced in September, 1915. On Dec. 6 five spans had been completed, the new sixth span was partly erected and the old seventh span partly dismantled, while falsework was being placed under the eighth span. Falsework was also being placed under the drawspan. Fig. 1 shows the condition on Dec. 1, and Fig. 6 shows some of the completed double-deck spans.

Navigation was closed officially on Nov. 18, but boats were allowed to pass until Dec. 4. The new drawspan must be ready for the opening of navigation this season. The weight of the new spans is about 190 tons for each 160-ft. span, 400 tons for each 254-ft. span and 680 tons

FIG. 6. NEW DOUBLE-DECK SPANS OF THE KEOKUK BRIDGE

for the drawspan, as compared with 120, 240 and 400 tons for the corresponding old spans.

The new bridge was designed by Ralph Modjeski, consulting engineer, of Chicago. The Strobel Steel Construction Co., of Chicago, has the contract for the entire work of removal and reconstruction.

Interlocking Wood Sheet Piles

In the wood sheet piling shown herewith each pile is made up of three planks that are easily shaped at the mill and may be spiked together at the site. When assembled, the pile has a T-head tongue and a slotted groove to receive the tongue of the next pile. Fig. 2 shows the construction of the pile and also the method of making an interlocked corner. The piles are of yellow pine and may be wholly or partly creosoted.

This sheet piling has been used extensively to form cutoff walls to prevent leakage under levees, also for bulkheads, foundations and caissons for bridge piers. Fig. 1 shows (at the left) the top of a line of sheeting in the Fairfield levee (with waling pieces bolted along each side); at the right is a caisson for a bridge pier in the New Basin canal at New Orleans. This caisson was made of piles 30 ft. long and was removed after completion of the pier.

For making a water-tight cutoff under levee embankments it has been employed on about 20 mi. of levee work in Louisiana, including the Fairfield levee, built by the Mississippi River Commission and described in *Engineering News*, Oct. 8, 1914. Major Sherrill, United States Corps of Engineers, reported that of various kinds of steel and wood sheet piling used this was "the only one that was entirely satisfactory."

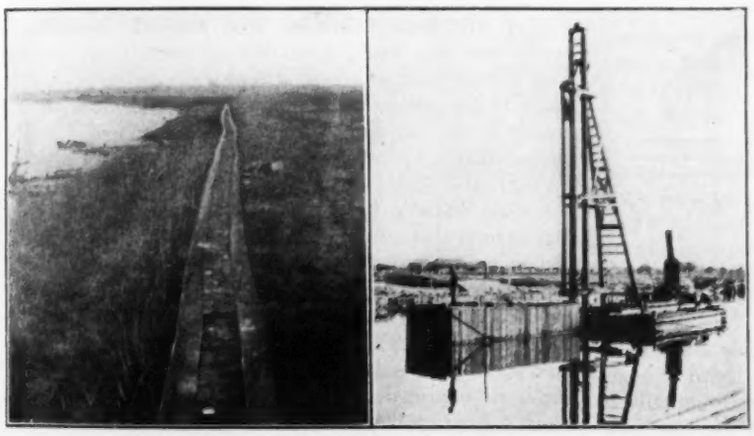


FIG. 1. INTERLOCKING WOOD SHEET PILING USED FOR THE CUTOFF UNDER A LEVEE AND FOR A BRIDGE CAISSON

According to a report of one of the engineers as made to Major Sherrill, the first 857 ft. (17,140 ft. in all) cost $4,309, of which sum $1,378 was for the driving. The direct cost to the contractor was $1.10 per lin.ft., 23c. of which was for assembling, but it was considered that with proper methods this item should not exceed 15c. The soil was "buckshot" and gumbo for the first 8 ft. and then blue clay. With a 2,350-lb. hammer and an average drop of 12 ft. an average of 80 blows was required to drive a 12-in. pile. Very close joints were obtained.

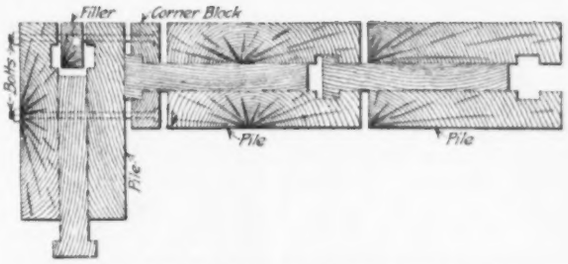


FIG. 2. INTERLOCKING WOOD SHEET PILING

This piling is designed by Albert A. Martinez, 908 Perrin Building, New Orleans, La. It is manufactured by the J. J. Newman Lumber Co., Hattiesburg, Miss.

Emergency Water-Supply at Danville, Ill.

An emergency pipe-laying job was done last year at Danville, Ill., by the Interstate Water Co., to remedy flood damages. In the past two years the company has increased its water-supply by means of a new dam in the Vermilion River. A temporary dam was built to provide for a possible drought in 1914 (as severe droughts had been experienced in the summers of 1911 and 1913), and it was intended to replace this structure with a larger concrete dam.

On July 31, 1915, there occurred a rainfall of 3 in. in 2½ hr., which caused a temporary levee to wash out. This flood caused a jam of driftwood to form against the falsework under the new Oaklawn Ave. concrete bridge, and the jam in turn caused the scouring out of the river bed, washing out four lengths of pipe in the 12-in. water main extending from the city proper to Vermilion Heights. As this was the only line supplying that district and as the break could not be repaired for some little time, it was necessary to lay a 12-in. emergency main, about 2,600 ft. long, on top of the ground and around the bridge site. Service was resumed in three days.

After the flood the temporary dam was replaced with one of timber and concrete construction, made 200 ft. longer and 6 ft. higher. It provides a pondage of 400,000,000 gal. in addition to that obtained by the older concrete dam at the pumping station, 4 mi. downstream. For water treatment hypochlorite has given way to liquid chlorine. The chlorine plant has been in operation only about a month and a half, but is giving satisfactory results as to bacterial reduction and cost of operation. H. M. Ely is Superintendent of the Interstate Water Co.

Causes of Forest Fires in National Forest Reservations are summarized in a bulletin issued by the Forest Service of the Department of Agriculture. There were reported on such reservations in 1915, 6,324 fires, but only 346, or 5½%, did damage in excess of $100. Lightning was the most prominent cause of forest fires, 28½% being of such origin. Other causes are reported as follows: Campers, 18%; brush burning, 11%; incendiary, 11%; railroads, 9%; lumbering, less than 3%; unknown, 15%.

Water and Sewer Improvements at Madison, Wis.

The City of Madison, Wis. (30,000 population), is now carrying out extensions to its water-supply and sewerage systems on lines recommended in 1915 by a board of consulting engineers. This board was composed of D. W. Mead, John W. Alvord, C. B. Burdick and C. V. Seastone. After the adoption of the present project for the extension of the water-supply system, Mead & Seastone, of Madison, were made consulting engineers, and they are now preparing working plans. E. E. Parker is city engineer, and L. A. Smith is superintendent of the municipal water-works.

The recommendations of the board for the extension of the sewerage system are being carried out on the lines suggested by the city engineer.

Present and Improved Water-Supply

The city's water-supply is obtained from deep wells and is delivered (by air-lift and electric well pumps) to two collecting reservoirs of 200,000- and 1,000,000-gal. capacity. From these it is pumped directly into the mains by steam pumping engines. A 50,000-gal. standpipe (12x 60 ft., in a brick tower) serves as an equalizer for domestic pressure on the distributing system. At times of fire this is cut out by a hydraulic valve controlled electrically from the fire-department headquarters.

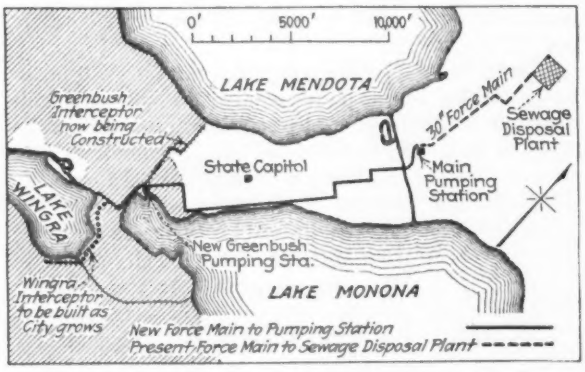


FIG. 1. IMPROVEMENTS TO SEWERAGE SYSTEM OF MADISON, WIS.

The well water is very hard, and a supply from Lake Mendota was strongly recommended by the board of engineers. Their report stated, however, that eventually a softening plant would be advisable even for the lake water. The well water was preferred by the city as being less liable to pollution, but in adopting it for the additional supply no provision was made for softening. The total quantity will be increased from 4,500,000 gal. to 9,000,000 gal. daily.

The present supply is taken from eight wells. Four wells at the pumping station (equipped with air lift in 1914) deliver 2,250,000 gal., and four wells—two with Wood impeller pumps and the other two with deep-well turbine pumps—deliver about 2,000,000 gal. The pumps and compressors are electrically operated. It was at first proposed to sink three new wells and equip them with submerged impeller pumps. The plan at present deemed advisable, however, is to apply the air lift to the four wells at present equipped with deep-well pumps and to two wells formerly under direct suction, but not now in use.

The water level in the wells, when pumping, is about 19 ft. below datum, and the level in the reservoir is about 14 ft. above datum, giving a total static head of 33 ft. The reservoir capacity will be increased to 2,700,000 gal. by the building of a 1,500,000-gal. reservoir. The pumping station will be entirely rebuilt, with the addition of boilers, a stack, overhead coal bunkers, coal- and ash-handling machinery and an 8,000,000-gal. high-service pumping engine. Some additions will also be made to the collection system, and an extensive equipment of feeder mains will be added to the distribution facilities. The plans for the new work are not yet completed.

Sewage Pumping System

The city's sewerage is on the separate system, and sewage is delivered to a disposal plant (opened in 1914), the effluent from which is discharged into Lake Monona. This disposal plant is at the northeastern end of the city. At the southern end are two small pumping stations with short force mains that discharge into the main intercepting sewer, 15 to 36 in. in diameter. This intercepting sewer is 15,300 ft. long, with gravity flow to a main pumping station, from which a 30-in. force main leads to the disposal plant—a distance of 9,500 ft.

The intercepting sewer is of insufficient capacity for present conditions. A new one will convey the sewage from the western part of the city to a pumping station in the southern part, which will deliver the sewage through a force main into the 30-in. force main leading to the disposal plant at a point just beyond the present pumping station. This plan includes a pumping station of 4,500,000-gal. capacity, a new interceptor 5,700 ft. long and a 20-in. force main 17,000 ft. long. The pumping station will have two 8-in. 3,000,000-gal. centrifugal pumps and one 10-in. 4,500,000-gal. centrifugal pump. This arrangement is necessary to provide against clogging, which in the present plant occurs at intervals of approximately 6 hr. In spite of screens all kinds of foreign matter enter the pumps and are gradually wrapped around the shaft and blades.

Special cleaning holes are provided on the pump casings to meet this difficulty. When the electric and venturi meters indicate this condition, the pump is stopped and another is put in operation. The handhole covers are removed, and the clogged pump is cleaned. This can be done in 5 min. The pumps work always under a head, their suction pipes drawing from a well beneath the floor, which is connected with the bottom of a reservoir, into which the sewage flows. This arrangement is shown in the section of the pumping station, Fig. 2.

Building the Intercepting Sewer

The Greenbush intercepting sewer, which will deliver sewage from the southwest section to the new pumping station, Fig. 1, is now under construction. It is entirely of cast-iron pipe, with lead joints, in order to prevent infiltration, as it is in water-bearing material and considerably below the groundwater level. Its diameter is from 12 to 24 in.

The trench is largely in wet sand and has a maximum depth of about 20 ft. In this material two lines of Lackawanna steel sheetpiling are driven on a length of 75 ft. of trench. The piles are 18 ft. long. Two horizontal pipes are laid between the sheeting, with hose connections to well points driven into the sand. A Nye pump, with

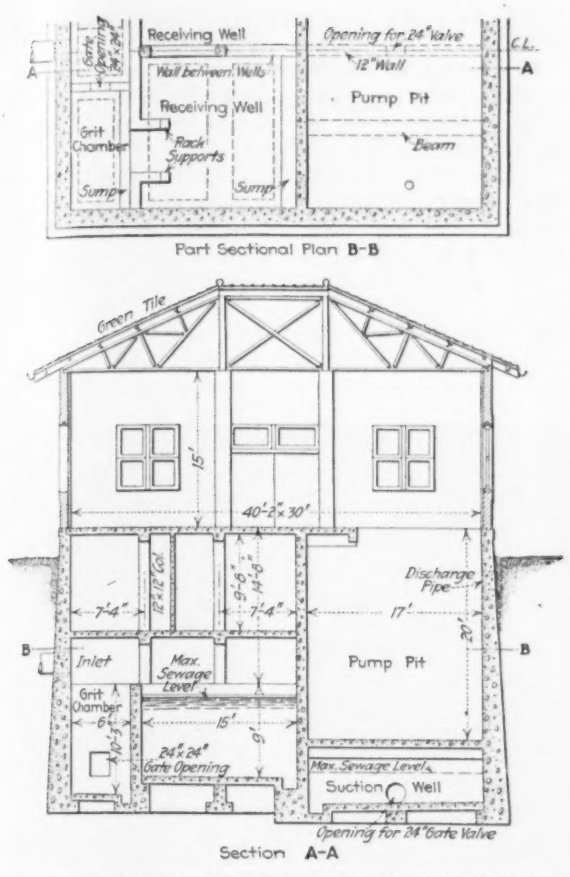


FIG. 2. NEW SEWAGE PUMPING STATION, MADISON, WIS.

hose connections to the suction pipes, serves to unwater the sand so that it can be excavated. The pipes are lowered by a chain hoist on a tripod; and when the joints are made, the end is closed with a blank flange. The sheeting is then pulled and redriven for another length of trench. John F. Icke, of Madison, is the contractor for this work.

Exhibition Testing of Concrete

By Donald A. Thomas*

At the Cement Show in Chicago this year, the joint exhibit of the portland-cement manufacturers was one of the most interesting features. Here the cement companies had combined their interests, producing an exhibit of high educational value. This article is concerned with one feature of that exhibit which attracted considerable attention—namely, the tests of concrete cylinders in the good-aggregates and mixtures booth. A great interest in the results of these tests was shown by many engineers, contractors and cement users who visited the booth. The writer, who was the demonstrator in charge, gives the values obtained, together with such other information as is essential to the understanding of the tests.

These tests were designed to show three things: First, that a 1:6 mix, using 1 part cement and 6 parts bank-run gravel, does not equal in strength a 1:2:4 mix of 1 part cement, 2 parts sand and 4 parts gravel. Second, that the strength of concrete is very materially increased by the use of washed sand and gravel. Third, that a "normal" consistency of mix produces a stronger concrete than a "sloppy" mix. In the latter case an attempt was made to show that, where an excess amount of water is used, there is a separation and often a loss of the cement, with a consequent loss of strength.

The test specimens were made in the structural-materials research laboratory of the Lewis Institute in Chicago previous to the show and, when tested, ranged in age from 28 to 34 days. The specimens were in the form of cylinders, 6 in. in diameter and 12 in. high, having a cross-sectional area of 28.3 sq.in. Gravel passing a 1¼-in. sieve was used in all cylinders, that retained on a ¼-in. sieve being used as coarse aggregate and that below ¼ in. as the fine aggregate. A 1:2:4 mix was used in all cases, except where it was desired to compare a 1:2:4 mix of graded aggregates with a 1:6 mix of bank-run material. Washed aggregates containing 1% of silt were used except where the comparison was made of clean and dirty materials. The dirty sand and gravel contained a total of about 8% silt. The same brand of portland cement was used throughout. All cylinders were capped with neat cement, to give a uniform bearing surface.

A 200,000-lb. hydraulic compression machine was provided for the tests. Two tests, comparing two cylinders of the same age, were made every hour during the show except at 12 noon and 6 p.m. In testing, the cylinders were centered upon the testing block, which was provided with a spherical seat; cardboard was placed beneath and on top of the specimen, which practically insured a uniform distribution of pressure over the entire surface. The load was then applied until failure resulted, and the total load sustained was immediately recorded upon a blackboard at hand. The application of pressure was continued until the piece had failed sufficiently to allow it to be broken apart with ease; and after being removed from the machine, it was left upon the table for inspection. A large number of interested people were always present when the tests were made, and many grouped about the gage, closely watching the pointer as it moved over the dial. The crushed specimens were usually subjected to much critical examination.

The accompanying table gives a résumé of the tests. An inspection of the specimen after failure often disclosed why it was strong or weak, as the case might be. The better grading of the 1:2:4 mix was always apparent. When clean materials were used, the aggregate would often be fractured or split, while the dirty gravel would usually pull out. The cylinders made from the sloppy mix showed more voids in many cases and a poorer distribution of cement throughout. Although in several cases the differences in strength were not great, a comparison of averages of all cylinders tested brings out the features which these tests were intended to illustrate.

COMPRESSION TESTS OF CONCRETE CYLINDERS
(Cylinders 6 in. in diameter, 12 in. high; age, from 28 to 34 days)

	Total Loads, in Lb.			Average Load per Sq.in.
	Maximum	Minimum	Average	
To test regrading (25 tests):				
1:2:4 mix	93,000	60,000	75,000	2,650
1:6 mix	73,000	39,000	59,000	2,020
To test clean aggregate (27 tests):				
Clean	98,000	63,000	77,920	2,750
Dirty	73,000	35,000	62,700	2,220
To test overwet mixes (14 tests):				
Normal consistency	97,000	70,000	79,030	2,800
Sloppy consistency	72,000	35,000	52,680	1,860

*836 East University Ave., Ann Arbor, Mich.

Wood-Block Pavement Is Improved by Traffic

EDITORIAL CORRESPONDENCE

The accompanying illustrations are interesting evidence that traffic on a wood-block pavement is necessary for its durability and protection from the weather.

The first of the accompanying views shows a pavement on West Commerce St., San Antonio, Tex., about 100 ft. ahead of an "omission" on the right-hand side. The Texas law is such that a homestead cannot be attached by a lien against the property for a paving assessment (or any other obligation), so that in certain instances it is necessary to omit the third of the pavement for which the owner of abutting property is expected to pay.

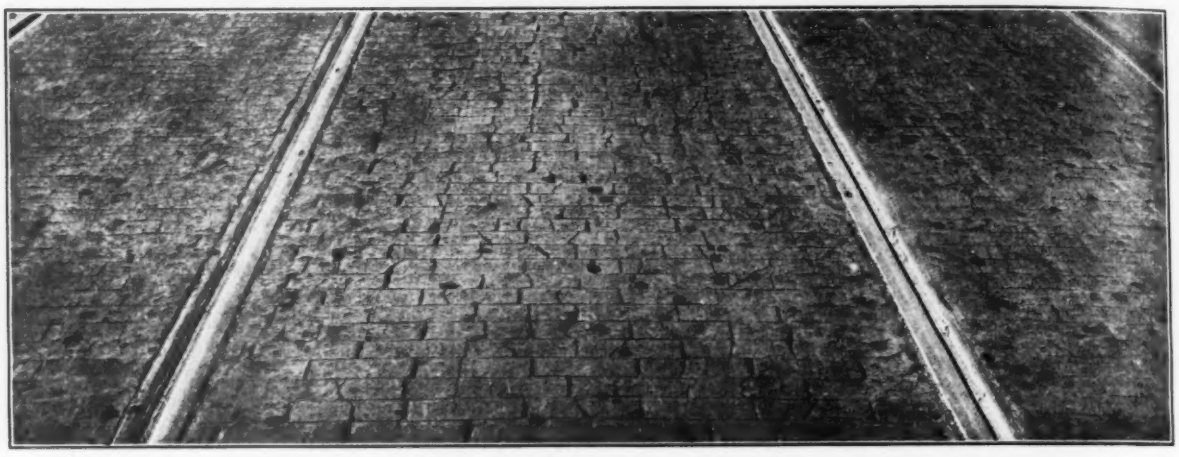


FIG. 1. WOOD-BLOCK PAVEMENT CRACKING WHERE NO TRAFFIC COMES UPON IT

The street is paved from curb to curb with wood block and except where these "omissions" occur there is very little traffic on the pavement in the space between the car tracks.

The second view shows the same street opposite the "omission," where traffic has turned onto the pavement between the car tracks, on account of the break in the paving at the side of the street. The difference in the pavement surface is noticeable but a careful examination led the observer to the conclusion that a number of cracks, similar to those shown in Fig. 1, existed in the pavement illustrated in Fig. 2. Owing to the ironing-out effect of traffic, these cracks were much less apparent.

The cracks are due of course to the shrinkage of the wood in drying out and are certain to occur where wood block pavement is not subjected to traffic and is exposed to very hot and dry weather.

Traffic over the wood blocks compacts the surface which is exposed to the air and the sun's heat and closes the pores of the wood. The grease, dirt and grit is imbedded in the grain of the wood and hinders the evaporation of the oil and moisture contained in the blocks. Incipient cracks which may form in the pavement by shrinkage are filled up as fast as they occur.

Troubles with wood-block pavement have occurred in some Texas cities where the pavement has been laid on very broad streets and plazas, where part of the surface received little traffic. In San Antonio the wood block has been laid almost exclusively on heavy-traffic streets and no trouble has been experienced.

About 8 mi. of the heavy-traffic streets of San Antonio have been paved with creosoted wood-block pavement during the last two years at average prices of $3.10 per square yard for 3½-in. blocks and $3.15 for 3-in. blocks. E. A. Kingsley is consulting paving engineer for the City Commissioners. Clinton H. Kearny is commissioner of Streets and Public Improvements.

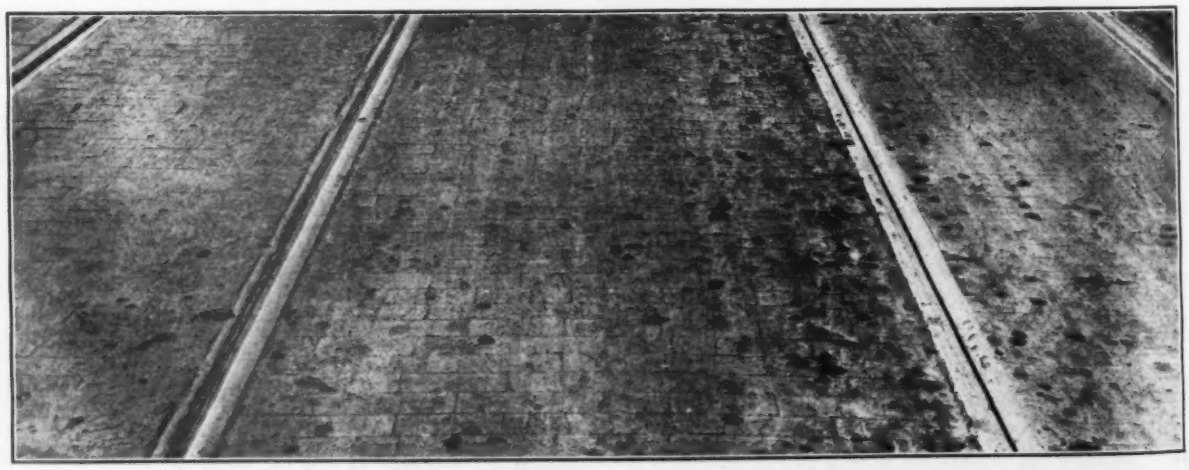


FIG. 2. SAME PAVEMENT AS SHOWN IN FIG. 1 UNDER MODERATELY HEAVY TRAFFIC

Navy Has Largest Experimental Wind Tunnel

By William McEntee*

The large experimental wind tunnel that the Navy Department has established in the Washington navy yard at the experimental-model basin has now been in operation about a year. The tunnel is the largest in the world, having a section 8 ft. square at the point where the models are placed for testing. In addition to the advantage gained by the size it is possible with a 500-hp. motor-driven fan to get wind speeds up to 75 mi. per hr., which permits experiments being made at real flying speeds.

The tunnel consists of a closed circuit shaped like the link of a chain, as shown in Fig. 1. The 500-hp. top-horizontal discharge fan is of the corrugated-paddle type, with an inlet diameter of 11 ft. 2 in. and a discharge duct 7 ft. 6 in. by 9 ft., and is placed at one end of the link. At the other end, where the air straightens out before flowing through the experimental chamber, are the baffles, which are necessary to remove the eddies and to control the uniformity of the speed. These baffles consist of 64 cells, each 1 ft. square and 8 ft. long. Each cell is provided with its own damper, so that the velocity of the air in any one section can be controlled. At

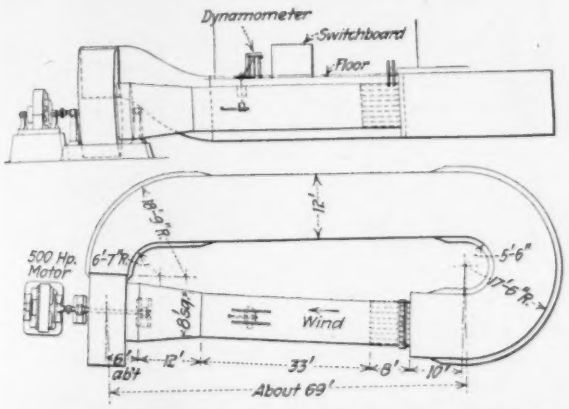


FIG. 1. LAYOUT OF U. S. NAVY WIND TUNNEL

the experimental chamber in the vicinity of which aëroplane wings or models are tested the maximum variation from uniform flow is about 2%.

The tunnel is built of wood; frames are spaced about 3 ft. on centers and are sheathed on the inside with ⅞-in. tongued-and-grooved sheathing laid in two thicknesses in the direction of the air current and with building paper placed between the two layers. The necessary curvature is obtained by bending the sheathing, the whole of which is blind nailed.

The fan is driven by a 250-volt 500-hp. direct-current motor, arranged with Ward-Leonard and auxiliary-field speed control, so that any desired speed up to about 200 r.p.m., which corresponds to a wind speed of 75 mi. per hr., may be obtained. At the discharge side of the fan are located 12 pitot tubes, which lead to an integrating manometer that gives the average velocity of discharge. This velocity has been calibrated against the

*Naval Constructor, United States Navy, Navy Yard, Washington, D. C.

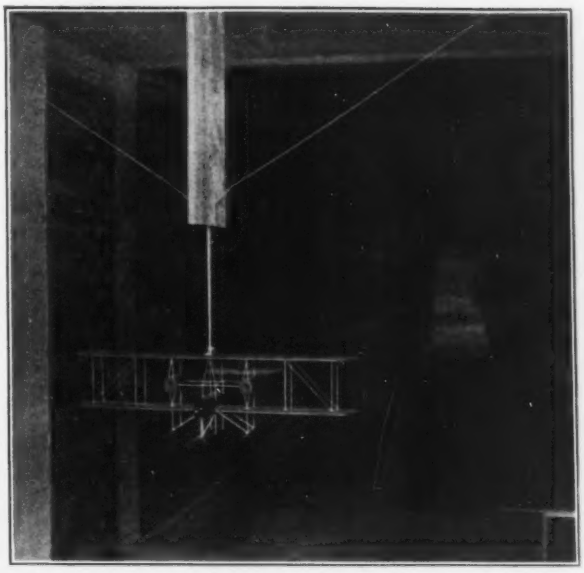


FIG. 2. MODEL AEROPLANE IN TESTING POSITION, NAVY WIND TUNNEL

velocity obtained at the section in the experimental chamber where the aëroplane or other model is placed, so that any desired velocity may be obtained with precision at that point without having any pitot tubes or obstructions other than the model being tested. In other words, by calibration the velocity of discharge may be found, and this bears a certain constant ratio to the velocity at the experimental section.

The velocities were determined by pitot tubes that were checked with those used in the aërodynamical laboratory of the Massachusetts Institute of Technology and in the National Physical Laboratory, England.

Investigations Already Made

Among recent investigations of interest made at the navy wind tunnel was the determination of the coefficient of air friction for various aëroplane and balloon fabrics. Tests have been made on the new dirigible building for the Navy Department and on models of naval aëroplanes both building and projected. A number of tests have also been made for private concerns. In carrying out experiments for private parties the same practice is followed as in the case of tests of ship models; that is, the actual cost of doing the work is charged in each case. On account of the large size of the tunnel it is possible to test comparatively large models of aëroplanes with widths up to 36 in.

In Fig. 2 is shown the arrangement of the model of an aëroplane when being tested. The model is carried by a steel spindle that extends up through the top of the tunnel to the weighing balance, which is placed overhead. For about two-thirds of the length in the tunnel the spindle is covered by a mask of stream-line form. This mask is secured to the ceiling of the tunnel and reduces the force acting on the spindle itself, and thus the spindle correction. The weighing balance consists of a weighing scale on the platform principle having three axes—two of them at the same horizontal line, 61 in. apart, and the third vertically over one of the first, 48 in. above it. When a model is set at a given angle, the moments acting about each of these three axes are

measured by weighing them on the scale. With these data it is possible to compute horizontal and vertical components of the force acting on the model—that is, the drift and lift—and also to compute the line of application of the force. Tests are usually made at speeds of 40 mi. per hr. At this speed and at the angle of least resistance an ordinary aëroplane-wing model has a horizontal resistance of something less than $\frac{1}{10}$ lb. It is therefore necessary that the balance should be capable of weighing a force with accuracy to about $^{2}/_{1000}$ lb.

The large size of the tunnel makes it possible to test full-sized radiators for aëroplane motors, and comparative tests have recently been made on several types, both as to air resistance and cooling capacity.

The wind tunnel has also been used for certain other tests that are not directly connected with aëronautics, such, for example, as the determination of the influence of form and dimensions on the size of ventilating cowls for use on ships. These tests have shown that it is not necessary to exceed certain dimensions, which are less than have heretofore been used in many cases. It is proposed shortly to obtain the wind resistance of a large battleship, this being an element of a ship's resistance that has not previously been accurately measured.

In conjunction with the wind tunnel the model basin is used for determining the best form of floats for hydroplanes, and there will no doubt be many other cases where the data derived from tests made in the water may be applied directly to aëroplane design.

Model Engineering Offices, City of Dallas, Tex.

A handsome municipal office building was completed by the City of Dallas in 1915. It has four stories and a basement and houses all the departments of the municipal government. The exterior is of white marble. On entering, the stranger is impressed not only by the handsome interior, but also by the business-like atmosphere and the total absence of typical city-hall surroundings—including politicians.

The basement contains the offices and station house of the police department; the first floor, the water department, bureau of sanitation, etc.; the second floor, the offices of the city commissioners (councilmen) and as handsome a city council chamber as can be found; the third floor, the city-engineering department; and here the stranger engineer will stop and admire. Fig. 1 shows a floor plan of this half of the third floor, and the figures inclosed in circles with the arrows show the approximate positions from which the views Figs. 2 to 7 were taken.

One enters a wide corridor, at the end of which is the office boy's desk, shown in the foreground of Fig. 2. Behind the railing are the desks of the assistant city engineer, the paving engineer and the permit clerk. The door to the left of the white post shown in Fig. 2 leads to the city engineer's private office, Fig. 3.

The city engineer's office is amply large and can ultimately be further subdivided. In front of the chief's desk are a mahogany table and chairs, where he may gather his heads of bureaus around him for a conference. On the other side of the corridor, passing either by the desks behind the railing shown in Fig. 2 or by the other passage shown on the plan, Fig. 1, is the main drafting room, Figs. 4 and 5. As will be seen, this is amply large and not yet fully utilized.

At the end of the drafting room is a fireproof record vault, in which the file plans are stored in numbered tin cases, as seen in Fig. 6. The card index of these plans is quite naturally considered a part of the city records and is stored in this vault. On the shelves opposite those in the view are others especially designed for field books. Separated from the record vault by a fireproof wall and entered from the opposite side, on the corridor, is the instrument vault, where all the more valuable surveying and scientific instruments are stored. This is plenty large enough to be used as a secondary record vault.

Going back to the city engineer's office, one can leave by a door opposite the desk, shown in Fig. 3, and pass into a large room which is divided by railings into three divisions, as on the plan, Fig. 1. Each division or compartment has a separate entrance from the main corridor as

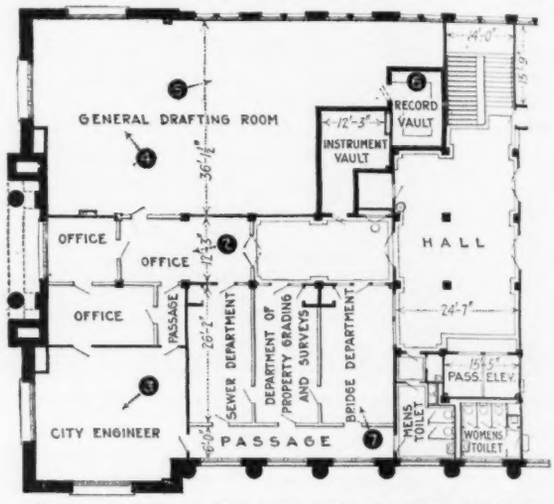
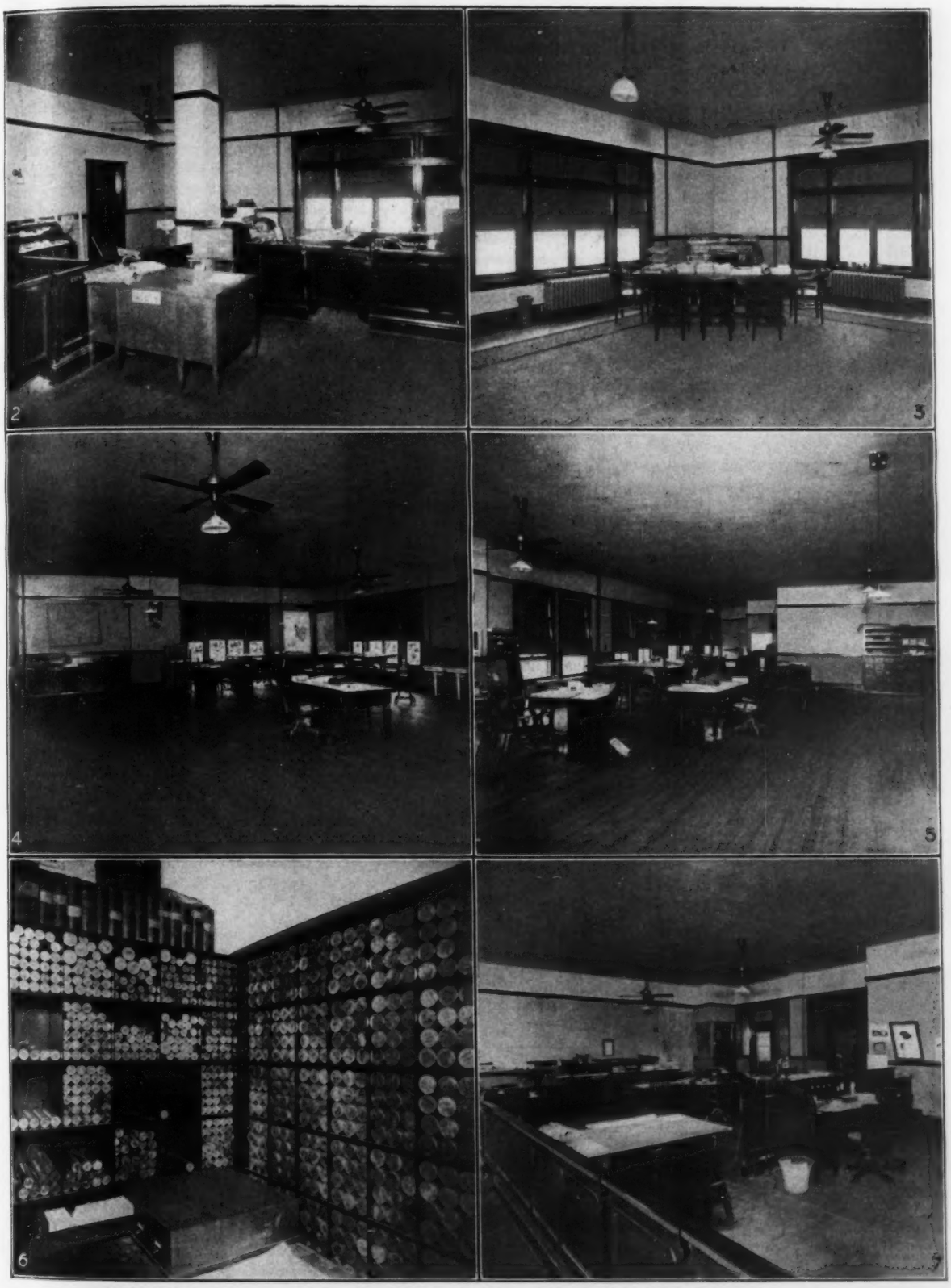


FIG. 1. PLAN OF ENGINEERING OFFICES OF THE CITY OF DALLAS, TEX.

well as from the private passageway on the opposite side of the room. Fig. 7 gives a view from this passageway. This room is for the assistant engineers and designers. The detail drawings are all made in the large drafting room, Figs. 4 and 5.

For the convenience of the commissioners and to avoid a good many trips between the second and third floors, a set of maps of Dallas have been prepared and mounted vertically in a handsome mahogany cabinet in the office of the commissioner of water and sewers. The offices of the commissioners and the mayor are all intercommunicating. This cabinet now contains two maps. One shows all the water-supply mains, hydrants, etc., giving sizes, and the other is a similar map of the sewerage system. It is intended ultimately to have a third map of a topographic survey of the city. In the city engineer's office are small-scale reproductions of these maps, on which by means of pins with different-colored heads the chief keeps tabs on various pavement openings and other work.

It goes without saying that the Dallas city government has a just appreciation of its engineers. One of the city commissioners, Otto H. Lang, is a consulting engineer. The fortunate city engineer to possess these fine quarters is Hal Moseley, and the architects who drew the plans for the building are C. D. Hill & Co., Dallas. The consulting architects were Mauran, Russell & Crowell, St. Louis, Mo.



FIGS. 2 TO 7—VIEWS OF THE INTERIOR OF THE ENGINEERING OFFICES OF THE CITY OF DALLAS, TEX.

Fig. 2—End of entrance corridor, assistant city engineer, paving engineer, permit clerk. Fig. 3—City engineer's office Figs. 4 and 5—General drafting room. Fig. 6—Interior of record vault. Fig. 7—Bureaus of sewers, surveys, bridges, etc.

City Planning by the Zoning System in the Bronx*

The future industrial development of the Bronx in New York City seems to be amply provided for in the zone plan now under consideration. In selecting residential areas and business streets to be restricted against factory buildings the commission has been careful to avoid anything that would stand in the way of a logical industrial development or tie up property suited to such development.

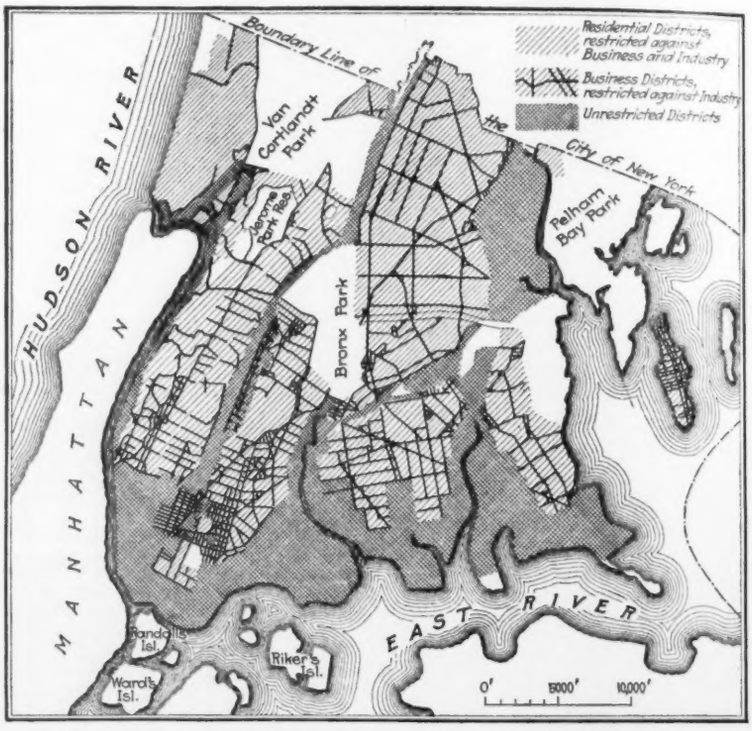
The proper location of a site for a factory or other industrial development depends largely on ready access to land and water transportation, easy grades and, for many industries, on distance from the business center of the city. The Bronx, being surrounded on three sides by water and having two large railroad systems within its limits, is advantageously situated in these particulars. Of about 575 mi. of waterfront in the city, the Bronx possesses 80 mi. The Hudson River shore on the west is not available for industry, on account of its steep slopes, but the lands adjacent to the Hudson River, the East River and the creeks leading into it are of low elevation and well adapted for industrial development.

At the present time industries are mainly located on a narrow belt along the Harlem River, on the Bronx Kills and on the East River south and west of Hunts Point, where a large industrial development is in progress, and along the Harlem division of the New York Central R.R. It will be noticed that all areas are in quick communication with the center of the business district of the city. Industry will necessarily have to go farther away as it expands, heavy industries requiring cheap land necessarily going farther than industries producing goods of high value. The location of two barge-canal terminals, the completion of the New York Connecting R.R., and the proposed industrial railway along a portion of the Harlem and East Rivers make it probable that the Borough of the Bronx will get a due proportion of the anticipated growth of industry in New York City, when room for such growth has been provided.

It is proposed to limit the height of all buildings in direct proportion to the street width, in accordance with present and prospective intensity of use. Three classes of height districts have been suggested for the borough, and they are shown in detail on a tentative height-district map. A height limit of two times the street width has been planned for a belt along the East River waterfront between Third Ave. and the Bronx River, where the most intense use is anticipated. All the remaining industrial areas in the borough are in districts in which a building height of 1½ times the street width is the limiting height, except certain inconsiderable areas in the more remote parts of the borough, where the limiting height is the street width.

Further restrictions are proposed as to the lot area that may be covered by buildings, which are shown in detail on a tentative area-district map. A belt along the Harlem River and considerable areas on the East River, belts along the Bronx River, Westchester Creek and the Harlem division of the New York Central R.R., New York, New Haven & Hartford R.R. and an area on the west side of Eastchester Creek may be considered warehouse districts. Storage buildings therein can ordinarily cover the entire lot up to the full height allowed. All factory buildings in these areas, however, shall have outer courts not less than 1 in. in least dimension for each 1 ft. in height above the street, when required by law to have courts.

All other industrial areas in the borough are in area districts that permit industrial buildings to cover the whole lot on the ground story only. Restrictions as to yards and courts limit the area that can be covered above that story. Yards above the first story shall be not less than 2 in. in least dimension for each 1 ft. in height of building above the street. When, however, a building is on a corner lot or is not more than 55 ft. deep, no yard is required. Requirements as to outer courts in these areas are the same as those in the warehouse districts.



TENTATIVE USE OF DISTRICTS OR BUILDING ZONES IN THE BOROUGH OF THE BRONX, NEW YORK CITY

On the original map the complete street system, with names of streets, was shown, but here all streets are omitted except those devoted to business, and for those the same symbol is used as on the original map. For strictly residential districts the original map showed the ordinary street symbols; and for unrestricted districts, the same, with round dots added. Undetermined districts (of which there are none in the Bronx) are shown by cross-hatching in the original series of maps.

*From a preliminary discussion of "Industrial Zones in the Bronx," by the Commission on Building Districts and Restrictions of the City of New York (Edward M. Bassett, chairman; Robert H. Whitten, secretary), Municipal Building, New York City. Similar reports are being made on other parts of New York City, and all the plans are being thrown open to consultation and criticism before the commission makes its final recommendations to the Board of Estimate and Apportionment.

Testing Every Rail Ingot by Fracture

Great increase of safety in railway operation, by detecting piping and segregation in rails, is arrived at by the plan of inspecting the interior of every rail ingot instead of only three ingots in each heat. This new plan was recently put into practice by R. W. Hunt & Co., as inspectors for the Canadian Pacific Ry., the Illinois Central R.R. and the Rock Island Ry., in the purchase of rails from the Algoma Steel Corporation, Sault Ste. Marie, Canada. The two photographic views herewith show how this system of inspection reveals segregation in the rail when the nonhomogeneity of structure is so great as to produce, or threaten to produce, brittleness. Fig. 1 is the fracture of a satisfactory rail, showing neither pipe nor segregation. Fig. 2, another rail fracture, shows a bright fine-grained center, interpreted as proof of dangerous segregation.

In a paper presented before the American Railway Engineering Association at Chicago on Mar. 21, 1915, Robert W. Hunt and C. W. Gennet, Jr., gave the results obtained by using this test on a large lot of 90-lb. rail for the Illinois Central. The inspection reports were made in such form that it was possible to tell which rails or heats would have been rejected under the 1915 specification of the American Railway Engineering Association. The important feature of the comparison is that the new system employed all the tests fixed by the other specification and also made a fracture inspection of each ingot. Thus the new system used all the information obtained under the old specification and much supplemental information, which resulted in discarding some additional bad rails and in saving some good rails that would otherwise have been rejected.

The A. R. E. A. specification requires drop tests on three top rails from each heat. With 15 to 20 ingots per heat, as in this case, only one-fifth or one-sixth of all the ingots are tested. Pipes or other defects in the untested 80% escape detection. On the other hand, if two of the three test rails are bad, all top rails of the heat are thrown out, whereas the Hunt "nick-and-break" method, which tests a piece from each ingot, will reject only the bad rails of the heat and will save the good ones.

The result of these differences is, briefly, as follows: In the entire lot of rail, involving 1,002 heats, 16,297 ingots and 69,826 rails, the old specification would have rejected 3,888 rails, while under the Hunt test only 2,083 rails were condemned. Thus the new test saved 2.58% of the entire order. At the same time not less than 930 rails (1.33% of the total order) possessing defects serious enough to cause rejection would not have been detected under the old specification, but were discovered and cast out by the Hunt test. About half of these bad rails were piped, the others segregated.

The Hunt test is made by taking the crop-end rail from the top of the ingot, quenching it from black heat to normal temperature, nicking it on head and base, breaking it at the nick by a bulldozer and inspecting the fracture for indications of piping or other seams or segregation.

FIG. 1. SATISFACTORY FRACTURE FROM TOP OF INGOT. NO SEGREGATION SHOWN

FIG. 2. SEGREGATION SHOWN BY FRACTURE. BRIGHT FINE-GRAINED CENTER

It is more fully defined by the following specification clauses:

> The test pieces which have successfully withstood the drop test and also a piece representing the top end of all other top rails shall be nicked and broken. If the fracture shows interior defect, the "A" or top rail of the ingot shall be rejected and a piece cut from its bottom end to represent the "B" or second rail of the same ingot. This piece shall then be nicked and broken; and if its fracture shows interior defect, the rail represented shall be rejected. The testing by nicking and breaking shall proceed progressively in this manner on all the rails of each ingot, if necessary, and they shall be accepted or rejected according as the fracture of the test piece representing them shows interior defect.
>
> The words "interior defect" shall be interpreted to mean seams, laminations, cavities, interposed foreign matter or a bright fine-grained center evidencing segregation, made visible by the destruction tests, the saws or the drills.

Three drop tests on top rails are made for each heat, as in the regular rail-testing systems. The above-quoted clause gives the entire difference of the Hunt specification from the A. R. E. A. standard.

Moving Forms for Building Storage Cylinders

In the article "Concrete Coal Cylinders Built with Moving Forms," *Engineering News*, Mar. 2, 1916, the author, Charles H. Higgins, stated that he was consulting engineer for the owner, preparing the plans, letting the contracts and supervising the construction, and that the General Contracting and Engineering Co. built the foundations and the concrete coal pockets. Julius G. Hocke, President of the General Contracting and Engineering Co., 29 Broadway, New York City, has called attention to the fact that the structural plans were made by his company and quotes the following paragraph inserted in the contract by Mr Higgins:

> The design of the work included in this contract, including all foundations and reinforced-concrete construction throughout, has been made by the contractor, who hereby assumes all responsibility for the strength, safety, adequacy and completeness of the finished coal pockets, until final acceptance by the engineer. . . . The test for final acceptance shall be made by the owner filling the pockets with coal and using these coal pockets in the usual course of business for a winter season.

Mr. Hocke states that the credit for this particular design is due to the company's engineer, A. M. Brothers, who introduced this method of construction with moving forms in building circular coal pockets in New York and vicinity.

Mr. Higgins, upon being informed of the contention, fully agreed with Mr. Hocke as far as concerned the design of the concrete coal cylinders, stating that this type of construction is fully dealt with in Milo S. Ketchum's book, "The Design of Walls, Bins and Grain Elevators," 1911 edition. Mr. Higgins' article was only a part of a general article describing the Perry coal-handling plant as a whole. The plant as a whole was a design of his office; it was executed by contracts let and carried out under the supervision of his office. There were seven contracts, of which the General Contracting and Engineering Co. had one, although not the largest.

The General Contracting and Engineering Co. has the privilege of using the patented device for raising the forms—in other words, the jacks—in the New York territory. Mr. Hocke states that it is his understanding that the patents for the jack are owned by R. H. Folwell and W. R. Sinks, 1811 Fisher Building, Chicago, from whom his company acquired the right to use the device.

Engineering Methods of Army Post Planning and Design

By R. C. Harbman*

In view of the present agitation for military preparedness, including an increase in our standing army, it may not be amiss to give a brief outline of the methods of housing our present army and the functions of the civil engineers connected with it, as an indication of the opportunities for civilian engineers in the event that the administration's program is carried through.

Our army is at present divided into two general divisions. The larger is the mobile army, comprising the infantry, cavalry, field artillery, engineers and signal corps of the combatant force and the hospital corps and army service corps of the noncombatant force. The smaller division is the coast artillery, which mans our seacoast defences, forming the immobile army.

The mobile army is quartered in a large number of posts throughout the continental United States, Alaska, Hawaii, Porto Rico (Porto Rico Provisional Regiment), Canal Zone and the Philippines (United States regulars and the Philippine scouts). The immobile army is quartered along our coasts, wherever protection is deemed necessary. The larger part of our numerous posts are of practically no strategic value, and many are in varying degrees of ruin and decay. As a rule, they are too small to accommodate an entire regimental unit, although there are a few notable exceptions, such as Fort William McKinley, Manila; Fort D. A. Russell, Cheyenne, Wyo.; Fort Leavenworth, Kan.; Fort Riley, Kan.; Fort Sill, Okla.; Fort Sam Houston, Tex.; and Schofield Barracks, Hawaii. Many of these posts, especially in the West and Southwest and including the $5,000,000 Fort D. A. Russell, have been slated for abandonment as being useless and of no strategic value; but except in a few minor instances the congressional "pork barrel" has been too strong. The Western posts are in large measure the remnants of posts that were of importance in the early days of unsettled frontier conditions and are in bad repair and constitute a large item of expense for upkeep.

Present Posts Could Be Replaced by a Few at Strategic Points

It has been the desire of certain army officials to replace practically all the present posts by the establishment of some eight or nine large posts situated at strategic points along our three coasts and two frontiers, with large reserve posts at suitable interior points. By this means it will be possible to have large masses of troops together for purposes of maneuvers and to reduce in great measure the cost of maintaining the military establishment. Aside from the question of expense the most criticized fault of our present system is the enforced division of tactical units; in many cases even so small a division as a regiment is split up into four or five detachments.

The construction and maintenance of the army posts are handled by the Quartermaster Corps of the army. The present corps is the result of the combination of the former Quartermaster, Commissary and Pay departments and has charge of the commissariat, pay, transportation, clothing and equipage (other than ordnance) in addition to the duties already mentioned.

*307 Cheyenne Boulevard, Colorado Springs, Colo.

Contrary to the belief of most civilians, who have at best a rather hazy knowledge of our army, the Army Engineer Corps does not do the engineering work of the army in connection with army posts, aside from fortifications and allied works. New construction in and around the posts is in charge of an officer of the Quartermaster Corps (a nontechnical man from the infantry, cavalry or artillery), who has as an assistant in direct charge of all technical matters a civilian engineer designated as Civil Engineer and Superintendent of Construction.

The engineering work in the construction of posts is extremely varied. In posts in the interior the work comprises building construction (including plumbing and electric work), water-distributing systems, water-supply systems (from wells, springs, and other sources), sewage and sewage-disposal plants, garbage-disposal plants, electric-lighting plants and systems, ice and cold-storage plants, walks, pavements; highways, bridges, storm sewers, reservoirs, rifle ranges, and in fact everything required to make the post an independent community. At posts situated by the sea, such as those for the coast artillery, these features may be supplemented by sea walls, wharves, docks, sewer outfalls and other works of a marine character.

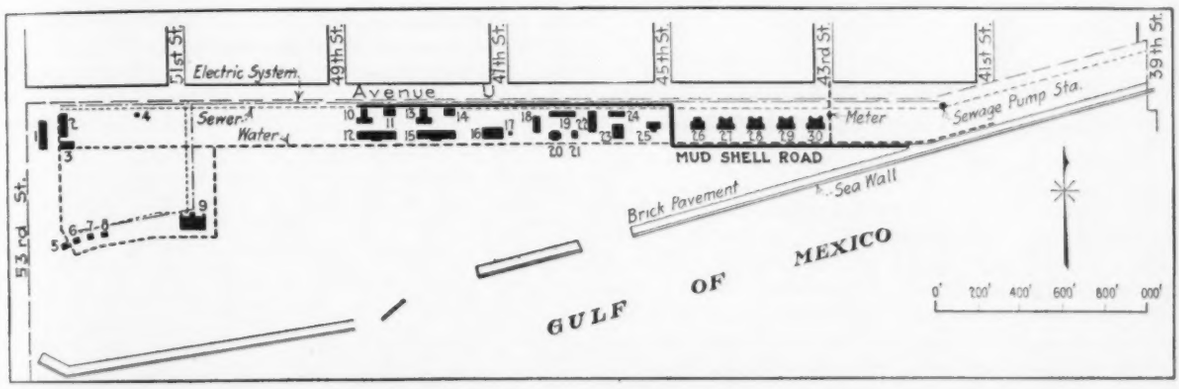
The buildings constructed are also greatly varied in character and include barracks, officers' quarters, storehouses, stables, magazines, bakeries, mess halls, lavatories, gymnasiums, guardhouses and shops of various kinds. Many of the older Western posts are built of adobe, while others are of stone, brick and wood. The newer posts are almost entirely of brick and concrete. Fort Sill, Fort Crockett (Tex.) and posts near Honolulu are among the later ones in which reinforced concrete is largely employed. In the Philippines wood and nipa palm are most commonly used.

Plans for buildings are generally prepared in the office of the Quartermaster General at Washington by civilians, although in many instances they are made by the local civil engineer. Plans for the engineering features involved are usually prepared by the local civil engineer, subject to the approval of the Quartermaster General. Work is nearly always done by contract, in some cases by day labor, or "purchase and hire," as it is officially called. Owing to the system of accounting, no exact figures covering the cost of any specific work can be obtained, as supervision, incidental expenses, transportation, etc., are not chargeable to the appropriation for the work. Construction by day labor is also handicapped by regulations covering the receipt of sealed bids for items of material, etc., and red tape of various sorts.

The work done is nearly always of the best class, no expense being spared to secure construction of a permanent character. While the first cost, per capita, is high, it reduces the large and constantly increasing maintenance cost consequent to flimsy construction. The per capita cost of Fort Crockett, Tex., upon which the writer was engaged, was about $2,000, which figure is for reinforced-concrete buildings founded on piles. The cost of officers' quarters was about $8,500 per capita, which extremely high figure is doubtless exceeded in posts housing the other arms of the service in which there is no congressional limitation on the cost of officers' quarters.

Our Posts Too Rambling; Denser Housing Desirable

The arrangement of posts has been much criticized because of their rambling nature. This is well exemplified in the accompanying plan. The sketch shows a new coast-artillery post (all buildings of concrete) housing two companies of 109 men each. While this arrangement has the advantage of being roomy and park-like, it necessitates an inordinate amount of engineering expense in providing water and sewer systems, walks, roads and so on. Not only is the original cost high, but the maintenance is equally expensive; and the care of the grounds requires on the part of the soldier much work that might be put to better advantage.



FORT CROCKETT, TEX., COAST ARTILLERY

1—Stable
2—Wagon shed
3—Forage shed
4—Oil house
5 to 8—N. C. O. quarters
10 and 13—Mess halls
11 and 14—Lavatories
12 and 15—Barracks
16—Gymnasium
17—Substation
18—Quartermaster shops
19—Coal shed
20—Bakery
21—Fire station
22—Quartermaster storehouse
23—Ordnance machine shop
24—Guard house
25—Administration
26—Commanding officer
27 to 30—Company officers

It has been suggested that the employment of the European system of housing would be advantageous, putting large units under one roof instead of constructing separate buildings for each company or troop, as in the United States. This plan has been tried, it is believed, at Corregidor Island, in Manila Bay, where one barrack has been erected for 14 companies of coast artillery. The scheme could be carried still farther to good advantage by providing apartment houses for officers. In fact, one large building could well house the entire regimental organization—officers, enlisted men, supplies and equipment—at an enormous saving in initial and operating expenses. Whether the attempt to adopt this system will succeed is problematical, as the army is very conservative.

The maintenance of a post after it is turned over to the commanding officer is attended to by a force of mechanics under the post quartermaster. These mechanics were formerly all civilians, but are now being replaced gradually by enlisted mechanics in the newly established Army Service Corps (noncombatant). Each post has a regular force of painters, carpenters, plumbers and blacksmiths, with such other mechanics as may be necessary to operate and maintain special works, such as ice plants, electric plants and sawmills. The system of maintenance, lacking a competent technical head, is unsatisfactory, especially in connection with the engineering features. It seems to be the rule not to keep any plans on file, and as a consequence, little is known of subsurface works. It is safe to say that at least one-third of the money spent on maintenance could be saved under proper management. The system is much the same as the one in vogue in our municipalities, where costly engineering works are placed in the hands of inexperienced men for operation and maintenance.

If our military establishment is to be enlarged as planned, immense sums will be spent for its housing; and it is sincerely to be hoped that the present rambling posts will be superseded by more compact and unified ones on the European system. It is still more to be desired, from the standpoint of efficiency, that the posts be located by the army staff instead of by hungry congressmen.

The Creative Imagination in Engineering Education

By William T. Carpenter*

There is at the present time a widespread discussion of engineering education. Various professors of civil engineering are bewailing a real or apparent falling off in the registration in their departments, and the engineering press is being fairly bombarded with explanations and denials. Without attempting to discuss this subject in general, the writer desires to point out what seems to him a defect in the most common method of teaching engineering. If he were asked to name the point wherein he considers his undergraduate course weakest, the reply would be that subconsciously the students acquired the idea that engineering is a finished science.

The courses in design were based on "This is the way to do it." If a plate-girder span were the subject for discussion, a blackboard sketch was supplied, showing all details, and the method of computation was explained minutely, so that the design became merely an exercise in arithmetic and drawing. The students, of course, were told by word of mouth that the successful men in after life were those fellows who could think for themselves and that principles rather than facts were the things to which the mind should be applied; but the minuteness with which methods of design were described tended to produce in the minds of the students the idea that the last word had been said and that any idea the student might independently originate must be one already tried in the balance and found wanting.

Principles, of course, were taught and insisted upon; but if the writer remembers accurately the sentiments of his classmates (and his own), the tendency was to shirk such study, on the assumption that, inasmuch as some pioneer had derived the formula and the tabulated values could be ascertained by referring to any standard handbook, any effort to get a masterly grasp on the great underlying principle would result in an accomplishment more ornamental than useful.

This tendency to explain to the student "how to do it" is apparently due to a failure on the part of the college to appreciate the essential difference between the objects sought in an engineering office and those to be sought in an engineering school. In the former the bridge, the railroad, the sewer is the object sought. In the school a trained brain is what is aimed at. Consequently, methods of instruction that are legitimate when a new man is being "broken in" to a job are not suitable to the training of men for the solution of problems some of which have no precedent whatever.

Progress in any line of human endeavor can only result when someone says, "That is indeed a way to do it, but not necessarily the way," and proceeds to try his idea. Progress may not result even then, but it surely cannot occur otherwise; and the earlier the instinct to seek improvement is instilled into the mind the greater the likelihood that the person will contribute to progress.

As this article is desired to be constructively rather than destructively critical, it remains to point out how the writer would go about instilling the creative instinct. First and foremost, the instructor must himself be creative. It is desirable, but by no means sufficient, that he should be thoroughly familiar with the best existing practice of his profession. The student should be shown how the present state of knowledge was attained. As an example, suppose the Kutter formula is under discussion. A short talk on the manner in which Ganguillet and Kutter arrived at their famous empirical expression for the flow of water in open channels will be very apt to set some of the students to wondering if the science of hydraulics is not even yet susceptible of some improvement. The laboratory should be substituted for the textbook as far as possible. A seminar course during the junior and senior years might well occupy some of the time now spent in detail studies which the student will probably have to relearn when he gets into practice. In this course the widest latitude of discussion should be encouraged. The writer, if charged with the conduct of such a course, would permit the student to question Newton's law of gravitation, if he would give some reason for his doubt. The engineering papers would furnish abundant material for such discussions; and while there would be some weird ideas brought to light, they would be ideas, "poor things, but their own."

The writer wishes to disclaim any idea that creative imagination is the whole story, that accuracy, concentration, patience, etc., are not equally important; but he does wish to claim for it a standing of no mean proportion in the equipment of the engineer and to urge that instructors in engineering strive to make their students create. Too often the graduate of an engineering school is able to do only what he has learned to do, paying for this knowledge from $2,000 to $5,000 and several valuable years of his life, whereas this sacrifice entitles him to a mental equipment placing him as far above the fellow who has "learned while he earned" as the financier is above the mere bank clerk.

*Engineer in charge, sewage-disposal experimental plant, Brooklyn, N. Y.

ENGINEERING SCHOOLS

Columbia University

This institution will hereafter confer the degree of master of science upon graduate engineering students who satisfactorily complete the graduate course in highway engineering. From 1911 to 1915 the graduate engineering students who specialized in highway engineering were candidates for the degree of master of arts.

An industrial-research engineering laboratory to cost $500,000, with equipment, and to have a foundation fund of $2,000,000 to $5,000,000, has been proposed by Dean F. A. Goetze and members of the faculty of the Graduate Engineering School of Columbia University. The laboratories would be open to manufacturers and individuals for the solution of any industrial and engineering problems.

University of Illinois

A mogul locomotive has been received by the College of Engineering from the Illinois Central R.R. It has been known in the records of the railroad company as locomotive No. 431. It has 19x26-in. cylinders and weighs with its tender 206,000 lb. It was taken from service and put through general repairs before delivery to the university.

This locomotive will be used for instructional work in the locomotive laboratory during intervals between researches involving the use of more modern engines, and ultimately will probably find a place in the university's locomotive museum.

University of California

The $1,800,000 of "University Building Bonds," voted by the people of California through approval of an initiative measure proposed by the alumni of the University of California for additional building work on the University of California campus at Berkeley, have been segregated by the regents of the university as follows: Benjamin Ide Wheeler Hall, a classroom building with a capacity of 3,500 students, its exterior to be of white granite, $700,000; completion of the university library, of which the present portion was built at a cost of $840,000, mostly defrayed by the bequest of Charles F. Doe, $525,000; second unit of the group of agricultural buildings, $350,000; first unit of a group of permanent buildings for chemistry, $160,000; new unit for the heating and power plant, $70,000; furnishings and equipment for the four structures first mentioned, $134,000.

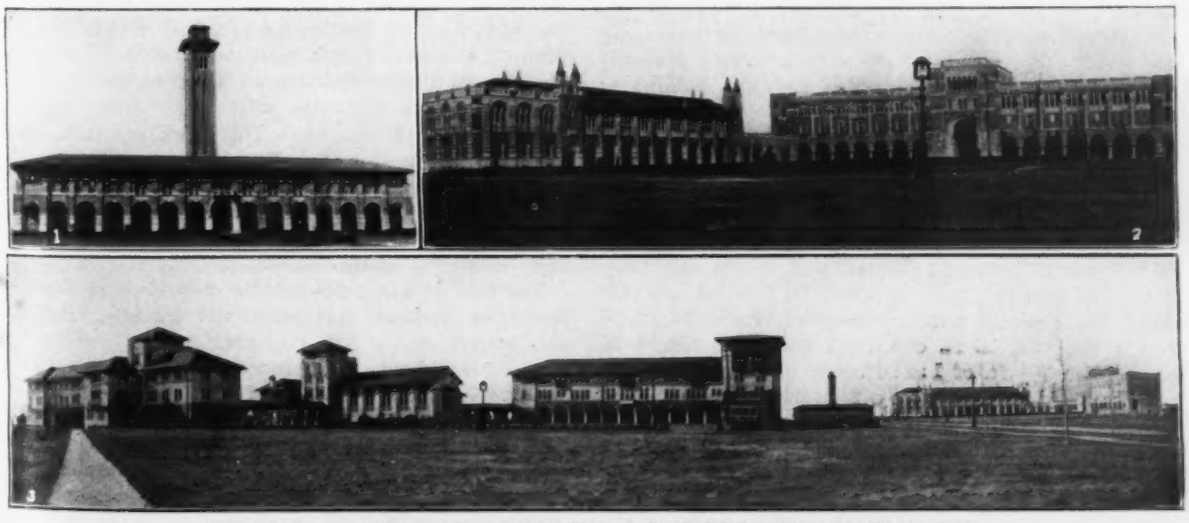
The steel frame for Benjamin Ide Wheeler Hall has been completed, and work has been begun on the setting of the granite. The contract for structural steel and steel erection has been let to the Pacific Rolling Mill Co. at $46,232, and work on the completion of the building is about to begin.

An addition to the university library is being made at a cost of $525,000. The part of the building now in use was completed about five years ago at a cost of $683,443, defrayed from the bequest of Charles Franklin Doe, and at a further cost of $200,000 for the steel bookstacks and equipment. The work now to be carried out will increase the book-storage capacity of the building from 300,000 to 1,000,000 volumes, though the full amount of bookstacks will not for the present be installed.

Rice Institute

Rice Institute, Houston, Tex., which was organized in 1908 and opened its doors in 1912, this year graduates its first class. In this class are seven engineering students, although the engineering courses were not started until 1915. There are now about 80 in the engineering courses. There will be ultimately four engineering departments—civil, mechanical, electrical and chemical. The head of the department of civil-engineering is Hugh Miller, formerly of the Clarkson Institute of Technology, Potsdam, N. Y.; the head of the electrical-engineering department is H. K. Humphrey, formerly with the General Electric Co., Schenectady, N. Y.

This institution, although America's newest technical school, is one of the most heavily endowed, having a fund of over $10,000,000. The trustees have adopted a policy of spending only the income, including expenditures for buildings and equipment. It is designed to have here eventually one of the finest institutions of the country. The accompanying views show the buildings, which were designed by Ralph A. Cram, Boston.



FIGS. 1 TO 3. CAMPUS AND BUILDINGS AT RICE INSTITUTE, HOUSTON, TEX.
Fig. 1—Engineering building. Fig. 2—Physics and Architecture (left) and Administration (right) buildings
Fig. 3—Campus with dormitories in left foreground

Field and Office

Plugging Old Water Tunnels

By F. A. Smith*

Two 7-ft. abandoned tunnels of the Chicago waterworks extend diagonally under private property instead of following the street lines, as in recent practice. The invert elevation being 42 to 62 ft. below datum, the tunnels have caused some trouble with deep foundations for buildings, as water entered them, although they were bulkheaded. At the office building of the Chicago, Burlington & Quincy R.R. the foundation piers broke through one of the tunnels; and although bulkheads were placed on each side of the structure, the water would rise in the tunnel to such a height as to flood the boiler room. The company, therefore, sank a shaft to the tunnel and installed a centrifugal pump, which had to be operated intermittently to keep the boiler room dry.

When the new Union Station was being planned, an agreement between the city and the railway companies provided for filling about 475 ft. of one tunnel and building several bulkheads. Fig. 1 shows the old and new water tunnels and also the plugging and bulkheading of the former.

The city decided to do this work with its own forces. It was in local charge of the writer as assistant engineer, and under the direction of Henry W. Clausen, engineer of water-works construction, and John Ericson, city engineer.

Closing the Crosstown Tunnel

The first operation was to sink a 4½-ft. shaft on city property east of the river. The tunnel was struck at about 60 ft. below the surface, and a No. 2 Emerson pump was operated day and night until it was pumped out. Meanwhile, another shaft was sunk south of the Burlington Building; and this was completed without difficulty, as the pump at the Madison St. shaft had lowered the water. The old bulkhead at Jefferson St., though of excellent concrete, was found to leak badly along the upper half of the circumference, evidently due to shrinkage of the concrete and the inability of making it a tight fit in the tunnel.

The filling of the tunnel proper began Jan. 25, 1915, starting at the bulkhead. A 3-in. pipe was placed in the invert to take care of the water and prevent hydrostatic pressure on the new concrete. The tunnel was filled for 20 ft. with gravel concrete (1:2:4). Next to this was 27 in. of 1:2 grout; then a 3-ft. clay bulkhead, well tamped; and next to this, 6 ft. of concrete. After the concrete were successively placed 53 ft. of 1:4:8 concrete, 12 ft. of clay, 7 ft. of concrete, 4 ft. of clay and 3½ ft. of 1:2:4 concrete. Still, the water would appear and nearly fill a 2-in. pipe that was placed in the invert.

It was decided then to place near Van Buren St. a special bulkhead 14 ft. in diameter and 2 ft. thick. In order to make sure of its being completely filled a 3-in. grouting pipe was sunk from the surface of the street, piercing the crown of the tunnel. The 14-ft. ring was excavated and the clay used for part of the filling, it always being well tamped against the wall of the tunnel. The flow of the water diminished, but a 2-in. pipe was placed near the bottom of the bulkhead to provide an exit for the gathering water.

A timber form was placed and the concrete bulkhead was poured Feb. 20, mixing the grout on the sidewalk and pouring it down the 3-in. pipe. The grout was composed of portland cement, torpedo sand and bank sand

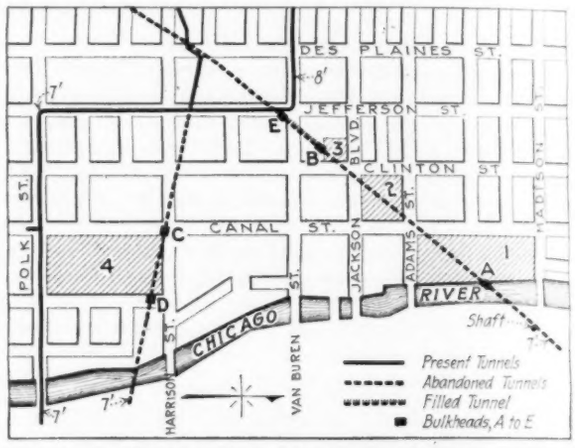


FIG. 1. PLAN SHOWING ABANDONED WATER TUNNELS
1—Track space for new Union Station. 2—Main building for new station. 3—Burlington Building. 4—Site for new freight terminals

mixed with a slight excess of water so as to make the grout of a semifluid nature to fill all the voids. Under the heavy pressure the wooden form bulged considerably, but did not fail, and the bulkhead was filled successfully.

A timber bulkhead that the Burlington company had placed was removed, and a timber frame was placed at the south building line, to act as a form for the concrete filling. A section (18 ft. thick) of 1:2:4 concrete was placed next to this form, then a 17-ft. section of 1:4:8 concrete, then a 6-ft. clay section and finally a 13-ft. section of 1:4:8 concrete. This work was done while the grout bulkhead at Van Buren St. was given time to set. Two rings 12 ft. in diameter and 3 ft. wide were also cut in the tunnel on each side of the shaft in preparation for the principal bulkhead, which was located right under the shaft.

The flow of water through the 2-in. pipe in the Van Buren St. bulkhead had practically ceased. This pipe was capped, and a 3-ft. clay plug was tamped next to the grout bulkhead. Then concrete (1:4:8) was placed for 62 ft.; next a 5-ft. plug of clay, well tamped; then 24 ft. of concrete; 8.5 of clay; 80 ft. of concrete with 5 ft. of clay plug; then 51 ft. of concrete; 14 ft. of clay and 6 ft. of 1:2:4 concrete. This brought the work up to the principal bulkhead previously mentioned.

The concrete for this work was mixed by a Hains gravity mixer, from the lower section of which it dropped

*Assistant Engineer, Department of Public Works, Chicago.

through a chute to wheelbarrows in the tunnel. The installation of this mixer required the excavation of a pit 6 ft. in diameter and about 12 ft. deep, so arranged as to intersect the 4½-ft. shaft on a 2-ft. common chord, sufficient to discharge the concrete into the chute in the shaft.

This work was finished Mar. 23, 1915, by filling the three rings in the principal bulkhead through the shaft with a rich grout of cement, torpedo sand and bank sand (1:1:1), making a total length of 474 lin.ft. of 7-ft. tunnel filled. The concrete mixer was then removed, rings and lagging taken out and the shaft above the bulkhead filled in.

The next stage was to build a bulkhead in this same tunnel just west of the river, opposite Monroe St. On account of a proposed bridge this bulkhead had to clear the future caissons, and the shaft for the bulkhead was sunk 25 ft. south of the street line. This 4½-ft. shaft

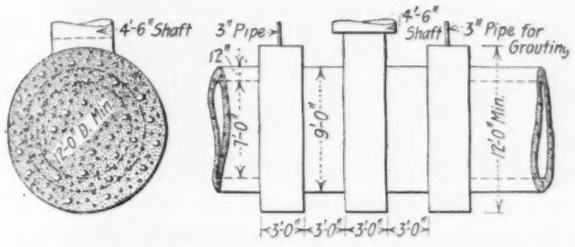


FIG. 2. BULKHEAD AT MONROE ST. FOR CLOSING THE OLD WATER TUNNEL

was 53 ft. 4 in. deep. It struck the tunnel Apr. 7, 1915, after which the cutting of the three bulkhead rings was continued until completion.

The shaft at Madison St. was kept open, with the pump ready for action should it be needed. But after the Van Buren St. bulkhead had been built, there was no further need of pumping; and on Apr. 13 the lagging and rings were removed and the shaft filled in. On Apr. 22 the bulkhead west of the river was filled in with grout, like the one south of the Burlington Building, the lagging and rings were removed, and the shaft was filled in with clay and sand on Apr. 25. Fig. 2 shows the design of this bulkhead.

There still remained the placing of two bulkheads in the old Polk St. tunnel, as shown in Fig. 1. A 4½-ft. shaft was sunk near Harrison and Ellsworth St., and at the same time a 3-in. grouting pipe was driven at the intersection of Canal and Harrison St. Much water was encountered in sinking the shaft and caused difficulty in reaching the tunnel. The No. 2 Emerson pump proved too small, and a No. 3 pump was kept going day and night until the water was down sufficiently for the men to walk over to Canal St. and cut the rings for the bulkhead.

A concrete bulkhead placed several years ago near Jefferson St. was found to be leaking badly, principally due to the shrinkage of the concrete. The center ring of the new bulkhead was placed under the 3-in. grout pipe; west of this was cut a ring 14 ft. in diameter and 3 ft. thick. A timber bulkhead was placed on each side of the ring, and then this section of bulkhead was poured through the grout pipe, a 2-in. pipe in the bulkhead permitting water to escape. After ten days this pipe was capped, and no further water appeared to leak through. As no water seemed to come from the east, pumping was discontinued.

The two east rings of the Canal St. bulkhead were finished and filled with grout May 15, through the 3-in. pipe. Just as the pouring was finished and grout was running in the pipe, the upper part of the east timber form broke, leaving the upper part only partly filled. This failure necessitated the cutting of another ring east of the bulkhead and the placing of a strong timber form. This ring was filled successfully on May 21.

In the meantime the three rings for the last bulkhead had been cut under the shaft. They were completed May 26 and were filled through a chute with 1:2 grout of cement and torpedo sand. The grout was mixed with an Archer concrete mixer. After this bulkhead had set two days, the rings and lagging were taken from the shaft and the shaft filled with clay and sand, thus completing the work.

Form for Ditching Reports

By Roy H. Allison*

The form shown has been used by me on the public ditching work of Blue Earth County, Minnesota. It is a combined progress and cost report that the inspector is required to fill out at the close of each day's work and to send to the engineer in charge at the end of the month. The sheet is 11¾ in. wide by 11¼ in. long.

*County Surveyor, Mankato, Minn.

PROGRESS REPORT

..... Ditch No..... Twp..... R....., ... County, Minnesota.

Subcontractor..... Month of .....19.....

	Date	Sta. to Sta.	Location	Tile	Average Cut	Soil	Machines	Machine Men		Foremen		Bottom Men		Laborers		Helpers		Total
								No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	
Sunday																		
Monday																		
Tuesday																		
Wednesday																		
Thursday																		
Friday																		
Saturday																		
Total for Week																		
Sunday																		
Monday																		
Total for Mo..																		

Remarks:

.....Inspector .....Engineer

Machine for Lining Ditches

A machine places the concrete lining of ditches of the Rio Grande project of the United States Reclamation Service, below El Paso, Tex.

It will be recalled that a machine of this general character and for this same purpose was developed and built on the Umatilla project in Oregon (machine described by E. I. Davis in *Engineering News*, Feb. 10, p. 264). The Texas machine is home-made and crude in some respects, particularly in its propulsion, which is by "pinching" with bars. The illustration gives an idea of the construction of this device.

An 8½-cu.ft. mixer is mounted on a four-wheel platform, which spans the ditch and is properly trussed to

CONCRETING MACHINE FOR LINING IRRIGATION DITCHES

carry a considerable load. The double-flanged wheels travel on a portable track consisting of 20-lb. rails fastened to 6x12 timbers laid flat. The timbers are laid end to end as shown and are not coupled in any way, but are aligned and held in place by stakes. The mixer is on one end of the platform. A device for dropping the loading hopper to the toe of the embankment was constructed of light channel bars. The portion of wheel just back of the mixer is the track for the lower runners of the hopper and constitutes the dumping mechanism. A cable attached to a hoist in the mixer operates the hopper. The concrete is discharged through a chute that has two outlets. One discharges on the slope nearest the mixer, the other on the bottom of the ditch. The method of using the machine is as follows:

The bottom slab is placed for several hundred feet in advance, moving the outfit a little every batch or two. The aggregates and cement are placed near the toe of the embankment at convenient intervals and brought to the hopper in wheelbarrows. When a section of bottom slab is completed and set, the machine is moved back to the point of beginning, and the slope slabs are made. The slope nearest the mixer is formed with the least difficulty, as the concrete can be discharged directly on this slope; to concrete the other slope, the concrete is discharged upon a mixing board on the bottom of the ditch and shoveled into place. The mixture is dry enough to stand on the slopes without forms. Four or five men are required to move the outfit, using the pinch bars. About 30 batches per hour is the normal rate of progress. R. F. Walter is project manager of the Rio Grande project. The work is done under his direction by day labor.

Sewage-Works Construction at Dallas, Tex.

Efficient handling of work is necessary in building the new sewage-disposal plant of Dallas, Tex., because the contract was taken on a very low bid. The principal items are a group of 12 Imhoff tanks, a reinforced-concrete outfall sewer to the Trinity River nearby and a sludge bed. A compact plant layout and supply of materials by rail direct to storage pile are elements of the work.

The arrangement of the contractor's materials and equipment is sketched in the plan, Fig. 1. The plant is all grouped on one side of the tanks and sludge bed in a long line parallel to the work, and behind it is a narrow-gage track connecting with the Missouri, Kansas & Texas track, over which material is brought in, at one side of the ground.

Excavation for Bed and Tanks

Excavation of the sludge bed was simple horse scraper work. The spoil was in part used for the embankment around the bed, the rest being wasted. Hand trimming (Fig. 3) finishes the work ready for concrete paving.

Excavation for the Imhoff tanks is carried on in two stages (Fig. 2). The first depth of 16 ft. is taken out by horse scrapers in simple excavation. From the bottom of this pit wooden sheeting is driven on the outer line of each tank, and within each such inclosure the pit is dug down by hand work with the help of a portable derrick to lift out loaded buckets and dump them on the east side of the tank.

To simplify the tank excavation, a deep open trench was excavated across the north end of the group of tanks. It drains to a sump at its east end, where is mounted a drainage pump supplied by a 45-hp. portable locomotive

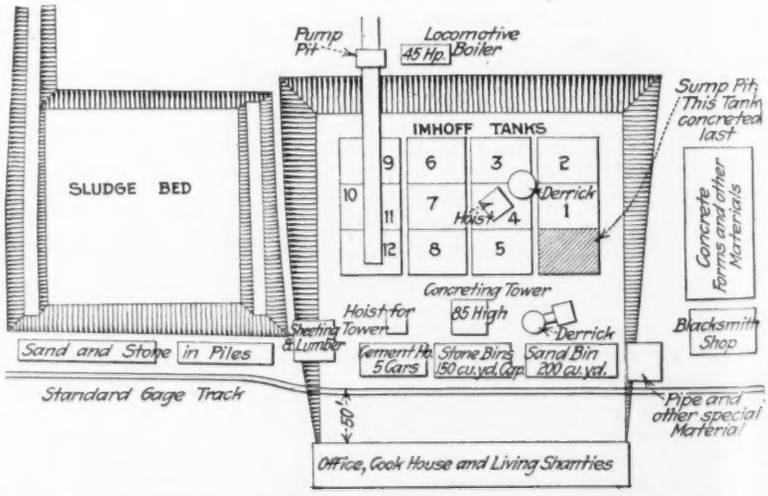
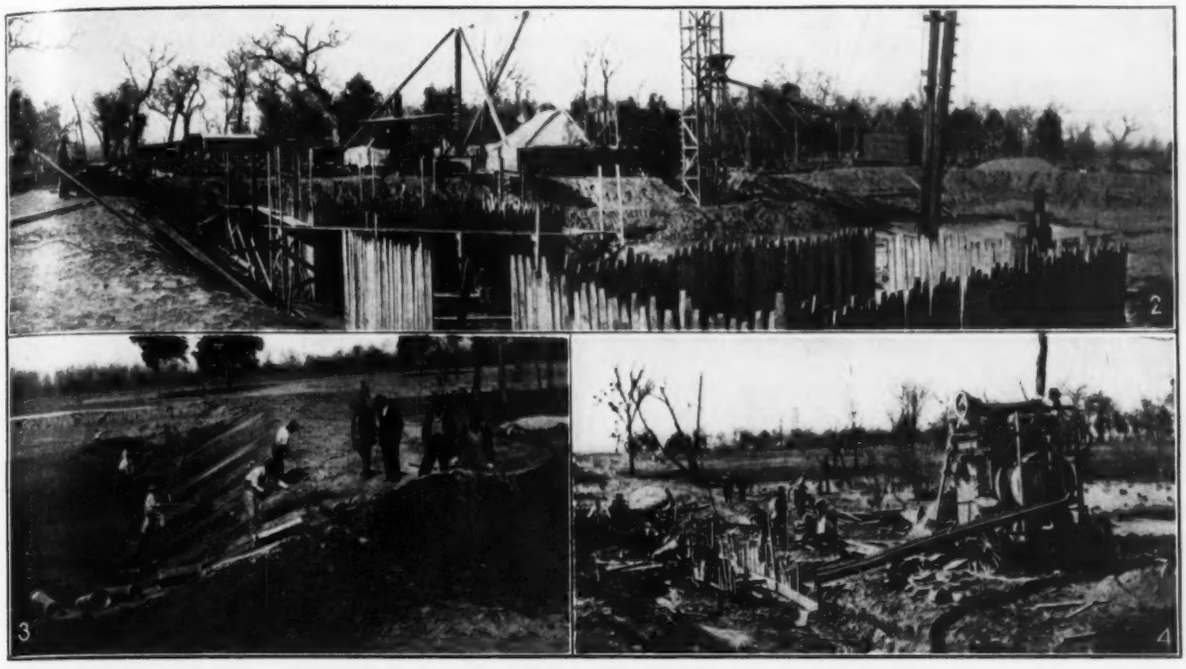


FIG. 1. SKETCH OF PLANT LAYOUT, DALLAS SEWAGE WORKS CONSTRUCTION



FIGS. 2 TO 4. PRESENT CONSTRUCTION ON DALLAS SEWAGE-DISPOSAL PLANT

Fig. 2—Excavation for Imhoff tank group and sheeting for individual tanks; drainage trench in background
Fig. 3—Slope trimming in sludge-bed excavation. Fig. 4—Paving mixer on outfall sewer

boiler. In addition, drainage during the concreting will be assisted by keeping the southwesterly pit open as a sump until the others are concreted.

The outfall sewer, several hundred feet long, extends through a swamp. A 3-ft. embankment or roadway was formed on the line of the sewer by dumping spoil from the tank excavation. This embankment served for teaming materials to the river end of the sewer (as the construction was to work upstream) and also simplified the problem of keeping out water.

Concreting Arrangements

The bin and mixer equipment is grouped along the track right in front of the Imhoff tanks. Storage piles for sand and stone are arranged along the sludge bed. The slope paving of the sides of this bed will be handled by a portable mixer (8 cu.ft.) supplied by wheelbarrows from the storage piles. In the floor work the concrete piers and the tracks for the sludge cars will be built first, and then the tracks will be used in supplying concrete for placing the floor slab.

The main concreting plant, intended for the tank concreting, comprises a cement shed with capacity for five cars, a stone bin of 150 cu.yd., a sand bin of 200 cu.yd., an 85-ft. tower (6x6 ft.) and a derrick that unloads railway cars by grab bucket. The tower will be capable of spouting concrete direct to any part of the tank. A runway from the cement house and bins to the tower provides for wheeling in cement and sand. Stone and cement are first delivered into a measuring box and from there are chuted into the mixer hopper. Sand is wheeled direct to the mixer. The stone chute is counterweighted and swings up out of the way of the wheelbarrow as soon as the materials have slid down into the hopper. The mixer is a 16-cu.ft. Smith machine. The measuring tank controls the water delivered to each batch.

For concreting the outfall sewer a 21-ft. Chicago-Smith paving mixer is used (Fig. 4). This same mixer was used for sewer work at San Antonio during the last two seasons, where it made a record of building a 6-ft. circular sewer at the average rate of 175 lin.ft. per day, a total of 15,000 lin.ft.

The working force, comprising about 70 laborers, is quartered back of the narrow-gage track; an office and cookhouse are provided here also. A permanent well sunk about 200 ft. behind the building, with pump and small concrete standpipe, supplies water for the camp as well as for construction, the drinking water, however, being filtered through charcoal.

The work is being done for the city engineering department of Dallas, under Hal Moseley, City Engineer, by Bailey-Reeder & Co., Mobile, Ala.

⌘

Track Anchors for holding railway track on overflow fills, described in "Engineering News," Mar. 9, p. 471, have been tried on a number of Southwestern railways. The sketch illustrating these anchors in the article referred to gives an erroneous idea of the method of fastening the wire cables to the track. In practice, of course, the wire passes under and is wrapped once or twice about the tie next the rail base, which prevents its slipping off. The wire then passes out under the tie on the other side. There is considerable difference of opinion as to the efficacy of such track anchors. Several miles of the Gulf & Interstate Ry. along the Bolivar peninsula to the terminus opposite Galveston, Tex., were protected in this way, yet the whole was washed out in the great flood of August, 1915. However, the water was probably 10 or 12 ft. over the track, which was subjected not only to the wash, but to the pounding of the waves. A curious result of the track anchors (which were of the pile type) was to cause the embankment at these points to scour several feet deeper than elsewhere, which would seem to be proof that the track at the anchors was held suspended long after the rest of the track had been washed out of line. Frank Merritt, Chief Engineer of the Gulf, Colorado & Santa Fe (owner of the Gulf & Interstate) has said that it is practically impossible to build on the beach of the Bolivar peninsula a track that will be proof against storms.

Recovering Stranded Ships After Galveston Storm

By Ellis D. Thompson*

On the night of Aug. 17-18, 1915, Galveston, Tex., was in the grip of a tropical hurricane. The rain was pouring in torrents, the wind had a velocity approximating 100 mi. an hour, and the gulf and bay were seething masses of water that poured over the sea wall and wharves, flooding the city. Four British tramp steamers without cargo were moored alongside the outer ends of the wharves with every available line out. Their sides were high above the tops of the adjoining warehouses. A mooring post gave way, and the "Ribston" swung out from its wharf, parting its 13 other mooring lines. In its rush down the harbor it broke the other steamers loose from their moorings. All had in water ballast, the "Harlesden" having a draft of 14 ft. The captain of the "Harlesden" told the writer that the night was so dark and the wind and rain so terrific that nothing could be seen or done, that he only knew he was adrift by the bumping of the vessel on the bottom and that in the course of 40 or 50 min. he felt the ship fetch up. When day broke, he found himself nearly 4 mi. inland and 7 mi. from his wharf, with the "Eaton Hall" a close neighbor, only 800 ft. away.

Of the other ships the "Ribston" was in the yard of the Southern Pacific Co., with her bow resting against a concrete turntable, while the "Wallace" was on Pelican Island within 300 ft. of the three-masted American schooner "Edna V. Pickels," which was floated in conjunction with the "Wallace." All the vessels were high and dry, flat on their bottoms in vertical positions and with their sterns to the bay, having gone ashore bow first.

The writer was engaged as dredging expert by the Salvage Association of London, representing Lloyd's, to examine and report on the ships, the cost of floating them and to supervise the work. The examination and report were made on Monday, Sept. 13. Bids were received the same night and cabled to London, accepted by cable on Tuesday, contracts entered into on Wednesday, and on Thursday and Friday four hydraulic dredges were at work on approach channels toward all the ships.

The distances the ships were from water deep enough to float them were: "Wallace," 3,000 ft.; "Ribston," 4,500 ft.; "Harlesden," 21,000 ft.; "Eaton Hall," 22,000 ft. The procedure was the same in each case. The approach channels were dredged 125 ft. wide and 13 ft. deep at low water, the depth being made more to facilitate the working of the dredges, as it was unnecessarily deep for the passage of the ships. Spoil was deposited from the end of about 400 ft. of discharge pipe carried on pontoons moving with the dredge. The average rate of progress was 350 to 400 lin.ft. of channel per day for each dredge, but this was modified as the ships were approached, on account of the difficulty of floating the pontoons in the very shoal water near the ships. The

FIG. 2. PLACING DREDGE PIPE FOR SLUICING OPERATION

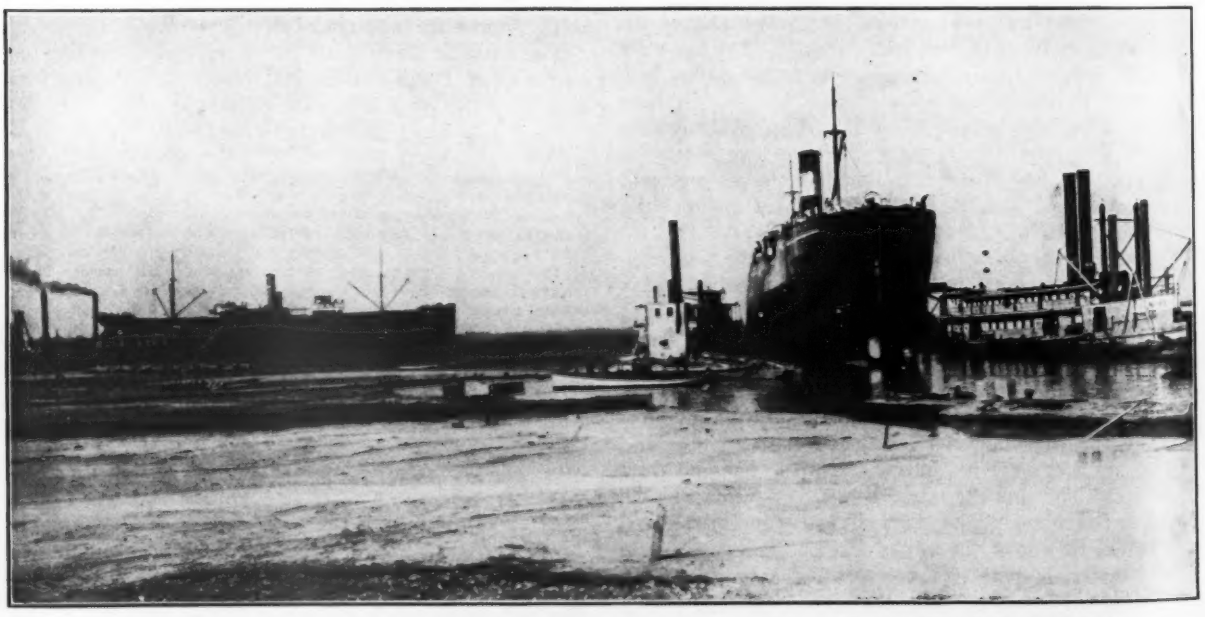


FIG. 1. DREDGING OUT THE "EATON HALL," GALVESTON, 4½ MILES FROM DEEP WATER

*Consulting Engineer, 210 South 42nd St., Philadelphia, Penn.

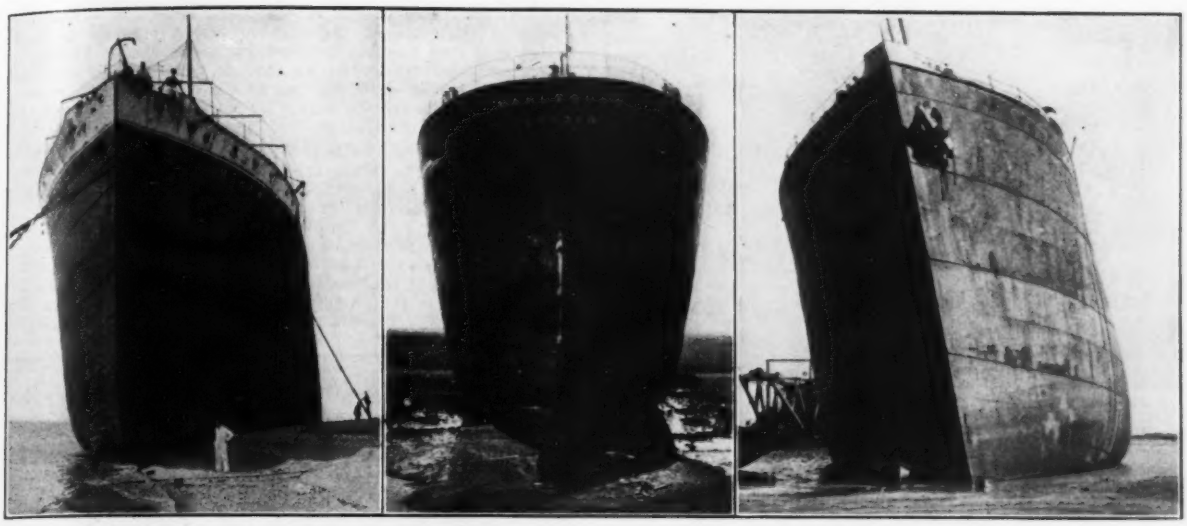


FIG. 3. THREE STEAMSHIPS WASHED INLAND BY 1915 GALVESTON STORM

approach channels were dredged completely across the stern of each ship, and then a floating basin 25 ft. deep and from 150 to 200 ft. in width was dredged along and close in to one side of the ship from stern to bow. The usual result was the caving of the material on which the ship rested, as far under as the keel, but no settling. This was effected by carrying the discharge pipe of the dredge along the undredged side of the ship and washing holes under the keel at intervals of about 8 ft., thus gradually weakening the earth support and allowing the vessel to settle from the stern to the bow.

This operation always resulted in a list of the vessel toward the floating basin of about 15°, the bow in every case being the last to float. The actual floating of the ship was a slide or lurch of several feet from its original bed toward the floating basin after half or more of its length from the stern had become waterborne. In the case of the "Harlesden," which was stranded on the prairie, it was necessary to dig an additional floating basin on the port side about 6 ft. deep and to use two dredges for washing. The marsh was underlain with clay and shells, which would not cave. This ship is 365 ft. long and 42 ft. wide and was the most difficult to float. In blowing holes to settle it both air and water were used, by lifting the suction pipe of the dredge up and down.

In the conduct of the work the utmost care had to be used in the actual floating of the vessels to avoid damage by strain. All contracts required the delivery of vessels at the Galveston wharves without damage due to salvage operations. Work under the contracts was prosecuted continuously by day, night and Sundays, and all the steamers were at their docks 51 days after the contracts were signed. They were uninjured in the slightest degree by the salvage operations, and only one, the "Eaton Hall," had to go into dry dock for repairs, having been rammed in the stern when it broke loose from the dock. The remaining three were ready to load cargo on arrival at their wharves. All came from their respective floating basins to the wharves under their own steam, the greatest light draft, that of the "Eaton Hall," being 9 ft. 8 in.

The contractor for the work was the Bowers Southern Dredging Co., Galveston, the operations being under the personal direction of C. L. Crandall, vice-president and general manager of the company. The salvage operations cost about 12% of the value of the vessels, while the demurrage of each vessel was estimated to be worth $500 per day in freight. Altogether, about 1,000,000 cu.yd. of material was dredged under the contract.

In addition to the vessels mentioned the interned Austrian ship "Morawitz" was also blown ashore. The accompanying photographs give an excellent idea of the difficulties and dangers in floating the various vessels safely and without damage.

NOTES

Simple Water Aërator at Leipsic, Ohio—To remove sulphurous odors from an underground water-supply derived from artesian wells some 600 ft. in depth, the village of Leipsic, Ohio, has installed a simple aërator. It is placed above the covered reservoir, just beneath the roof. The water as pumped from the wells is discharged downward through a 6-in. vertical riser, overflows and passes down through what might be termed three sets of perforated trays, one above another. These trays are composed of boards perforated with numerous ½-in. holes. The trays are hexagonal in plan and about 3 ft. apart vertically. There are openings in the reservoir cover, provided with wire screens, which afford ample ventilation for the removal of the odors. W. A. Bell is Superintendent of Water-Works at Leipsic.

Taking Samples of Air and Gas for chemical analysis has often been done by emptying water-filled tubes in the body of gas to be tested, the water of course being at once replaced by the gas. A more convenient apparatus for sampling air or gas has been designed by R. L. Oberholser, Chief Chemist of the New York City Public Service Commission, and was described by him in the "Public Service Record" for December. The apparatus consists of glass tubes 10 in. long and 2½ in. in diameter, with a stop-cock ground in at each end. They are exhausted of air in the laboratories by a mercury-displacement apparatus, giving in the tube a vacuum 99½% perfect. These vacuum tubes have been extensively used in making samples of the air in the subway tunnels and cars in connection with the study of ventilation systems.

A City Ford at San Antonio, Tex.—meaning a stream crossing and not an automobile—is shown herewith. The concrete pavement is carried across the bed of the stream, so that under normal conditions about a foot of water flows over this part of the pavement. The ford is on a short street cutting across a little distance above two intersecting main streets. The stream is carried under the main street through a concrete culvert, so that it is not necessary to use the ford, if one travels a few hundred feet extra. This method of

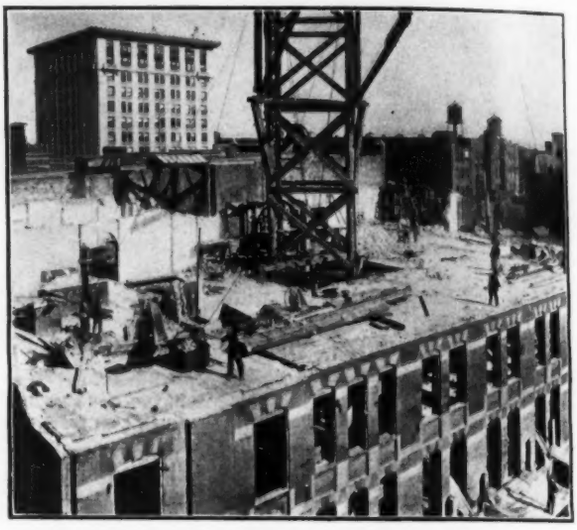
PAVED FORD ON A SAN ANTONIO STREET

dishing the roadbed and going through streams and gullies is quite general on roads in the dry parts of the West. Such construction is much cheaper than any form of culvert, and most of the water courses are dry or practically dry during a large part of the year.

New Triangulation Signal Lamp—An improved electric signal lamp has been devised by E. G. Fischer, Chief of the Instrument Section of the United States Coast and Geodetic Survey, for the triangulation work of the Survey. The main part consists of an automobile headlight properly mounted for horizontal and vertical directing. For maximum intensity a type of gas-filled bulb was developed by a manufacturer, securing a more concentrated filament than in any lamp found on the market. It requires 2.5 amp. at 6 volts and is supplied by current from dry cells. The latter were found superior to storage batteries because of ready divisibility into pack loads for difficult climbs. Flash signals are to be employed in order to reduce the current consumption, instead of burning the lamps from sunset to the end of the night's observations, as now. The whole outfit in a case weighs 23½ lb. The apparent candlepower at 100 ft. of the acetylene lamps formerly employed is 1,500; the apparent candlepower of the new lamp is 250,000. This increased power is expected to increase the number of observing nights by 25%.

Side-Dump Car Capsized by Its Load—As a result of the material choking up the discharge, a side-dump car fell down a railroad embankment in Cleveland, while dumping. The dark objects in the lower left-hand corner of the view having the appearance of rocks are earth of a clayey nature, compressed into solid lumps by a clamshell bucket. As is well known, in discharging load from this type of car (Western air dump) the body is tilted by air power and the side boards are automatically raised at the same time. In discharging the load that caused the accident several lumps of earth rolled into and blocked the opening between the tilting car floor and the sideboards. As the car came to full tilted position, the load of earth rushing to the stopped opening jerked the car from the track. Many loads of dirt in the same condition had been handled previously without accident.

A Derrick Tower To Demolish a Building was tried out in Nashville, Tenn., in razing the Cole Building, a five-story office structure. This tower will also be used in the construction of the reinforced-concrete Fourth and First National Bank, to be built on the site. The Cole Building was of iron frame, with wood-joist floor construction, and required heavy equipment to demolish it. A space was cleared in the center of the building, straight up, the floors being broken through for the purpose. The joists, as they were taken out for the opening, were used in the construction of the tower, which is 16 ft.



DERRICK TOWER USED IN BUILDING DEMOLITION

square by 136 ft. high. The main posts are 12-in. piles with the joists as crossbracing. The tower is braced to the floor at each level and is equipped with two 63-ft. booms placed on opposite corners. Each has a 30-ft. mast on horizontal timbers passing through the tower. The masts were lowered twice during the wrecking. The derricks are used for lowering buckets of brick and for moving steel and timbers. The Foster & Creighton Co. is the contractor.

DUMP CAR AFTER ROLLING DOWN EMBANKMENT; NOTE THE LUMPS OF EARTH THAT CAUSED THE ACCIDENT

Editorials

The Pending Question in the Civil Engineers Society

We have received from Col. W. D. Pickett, Lexington, Ky., the only surviving charter member of the American Society of Civil Engineers, a letter discussing the question on which the members of that society are now taking a letter ballot—whether the society shall remove its headquarters in New York City to the Engineering Societies' Building. The substance of his letter is as follows:

As the only surviving member of what have been designated "charter members" of the society (the members of the first year of its existence), I do most earnestly protest against the acceptance of the proposition.

The American Society of Civil Engineers, since the first year of its existence—1853—has increased from a membership of about 50 to nearly 8,000. Its membership occupy honorable positions in every country of the globe. It has grown much faster in the professional character of its members and in the influence of the society as an organization until, at the present time, it is not surpassed in character and influence by any similar society in the world.

This has been accomplished without help from any source and with no danger of having the name of a multimillionaire nailed over our portals.

The proposal is that we shall give up our home on 57th St. and join with the other three societies (the electrical, the mining and the mechanical engineers) in the occupancy of the Engineering Building on 39th St., erected for them free of cost by Andrew Carnegie about ten years since at a cost of $1,050,000. The cost of building and grounds is placed at $1,717,000.

Upon the broad proposition of accepting or rejecting this offer there should be no question; it should not be accepted. It would be a lowering of the dignity and influence of the American Society of Civil Engineers to go into partnership with any society, however distinguished.

Of course, there should be the most cordial coöperation with these three organizations, as they exist today. They are all special branches of engineering, but the principles of civil engineering lie at the foundation of each of them. But this coöperation can exist just as cordially with the headquarters of each a few blocks distant as if they were next door.

This is the only letter which *Engineering News* has received in opposition to the proposed change in headquarters of the American Society of Civil Engineers.

Colonel Pickett's arguments may be reduced to practically two. The first of these is in substance that the American Society of Civil Engineers ought not to accept the pending offer because the money for the construction of the Engineering Societies' Building was a gift from Andrew Carnegie. The fact is that Mr. Carnegie has no more ownership or control of the Engineering Societies' Building, which he gave to the engineering profession of America twelve years ago, than has Colonel Pickett himself. It should be emphasized further that in all the transactions that took place a dozen years ago there was never the slightest evidence that Mr. Carnegie was animated by any other motive than the desire to make a munificent gift to the engineering profession, to which he was so largely indebted for his great success. Indeed, the American Society of Civil Engineers at one time solicited and accepted gifts of large amounts and gave to those who contributed $250 or more the title, "Fellow of the American Society of Civil Engineers." Was this charity?

Turning now to the other objection voiced by Colonel Pickett, it is best expressed probably in the following sentence, "It would be a lowering of the dignity and influence of the American Society of Civil Engineers to go into partnership with any society."

In order to get a clear idea of what this objection means, let us see exactly what the phrase "going into partnership" means. It means that the society would join with three other national engineering societies in the ownership, occupancy and management of a building erected as a great headquarters and center of activity for the American engineering profession. The society would have in this building its own separate offices and general headquarters for the use of its membership and staff, just as do the other national societies that are joint owners. It would share with the other societies in the use of the auditoriums, rooms for public receptions, etc., in the building (which, it may be here noted, are far more convenient and better adapted to the society's needs than any other auditoriums in New York City).

The society would in addition, *if it chose so to do*, add its own library to the consolidated library of the other three engineering societies and join those societies in the ownership and management of the combined library. The great advantage of doing this need not be here discussed, for it is an optional feature of the plan. If the civil engineers prefer to keep their library separate from the others and carry it on as they have in the past, they are at liberty so to do.

This is the "partnership" which is now open to acceptance by the American Society of Civil Engineers. Wherein would "the dignity and influence of the society" be lowered by such a partnership? It must be understood that these other national societies are organized on lines similar to those which govern the organization of the American Society of Civil Engineers. They are professional organizations, not commercial. In membership, in professional standards and in prestige and influence, these societies approach, even if they do not equal, the older society.

It is not a really serious question for the American Society of Civil Engineers whether its New York headquarters shall be located at one place or another. It *is* a serious question for the engineering profession what the general attitude of this oldest and largest of the national societies is to be toward the other national societies.

It is well known to the older generation that a quarter of a century or more ago a good deal of bitter feeling existed in the American Society of Civil Engineers toward the other national societies. It was this "I am holier than thou" attitude on the part of a few of the old-time but influential members, coupled with a general misunderstanding of the proposition, which caused the unfortunate defeat, a dozen years ago, of the proposal to join the other national societies in the erection of the great building on 39th St. There is every reason to believe, however, that the old-time antagonism has practically disappeared. It is the needs of the present and of the future that should govern the policy of the American Society of Civil Engineers and not traditions of the bygone past.

Government Engineering Bureau a Century Old

Probably many members of the engineering profession may be doubtful at first thought as to whether the United States Coast and Geodetic Survey, which celebrated its centennial at Washington last week, is an engineering bureau. It is of interest to reflect therefore that, a century ago, surveying was about all there was of engineering. At that time and for many years afterward the chief work of the engineer was the making of accurate measurements with certain instruments—the compass and theodolite and level and chain.

We have traveled far from that day, and the engineering profession has grown to vaster proportions than any scientist or engineer dreamed of a century ago; but it should not be forgotten that surveying—the application of scientific methods to the art of earth measurement—is as truly engineering work as is any other application which the engineer has made of science and scientific methods to industry.

The entire engineering profession, therefore, may justly take pride in the remarkable tribute which has been paid to the Coast Survey and its officers, in the centennial celebration of its establishment, by the chief Government officers, including President Wilson himself, and by the leading men at the nation's capital. It is a significant fact that at this time of national stress the men in charge of affairs at the seat of government should turn aside from their weighty responsibilities to join in thus honoring the Government's first scientific and engineering organization.

At this time, when the Government is embarking more largely than ever before on engineering and industrial works and when the question how it can best carry on these works is most pressing, it is worth while to draw some lessons from the history of the Government's oldest engineering organization. Those who know the history of the Coast and Geodetic Survey will agree that one reason for its success and for the high character of its work has been the long tenure of office of most of its superintendents. In the century since it was organized it has had only ten superintendents. The first two of these, F. R. Hassler and Alexander Dallas Bache, served from 1816 to 1867, or 51 years, and O. H. Tittman, who retired last year, was superintendent for 15 years.

Doubtless the small compensation paid and the obvious need of high scientific ability for the conduct of the work were among the reasons why the Coast Survey did not suffer as did other Government bureaus from the corruption of politics; but be the causes what they may, it is certain that no such high standard of efficiency could have been maintained throughout its century of history had the superintendents been superseded with every new administration, with consequent inevitable changes in policy and in organization.

It is worth mentioning, too, that with all the high reputation of the Coast Survey it failed—as engineers too often fail—to make its work and its service so well known as to secure the public support that it deserved. The Coast and Geodetic Survey began the work of mapping the national domain with its system of geodetic triangulation. It was the logical organization to carry forward this work and produce such detail maps as are now made by the United States Geological Survey.

But just at the time when the Coast Survey might have expanded the field to meet this public demand, it was under a cloud; there was no one at its head capable of commanding the confidence of Congress sufficiently to expand its field so as to undertake the work of topographic surveying and mapping. At this very time the Geological Survey, originally founded only to investigate the national resources in the public lands in the far West, was headed by a man of great popularity and ability. He saw the opportunity, his influence with Congress was sufficient to secure the necessary funds, and as a result we have the anomaly that one Government survey bureau conducts the triangulation for mapping and makes detail topographic maps of the coast, while another bureau makes detail surveys and maps of the land areas. It is by such accidents as this and not by a definite system of intelligent planning that our governmental organization has been to a large extent built up.

Build Enduring Bridge Piers

Engineers ought to make it a fixed habit to carry bridge foundations down below possible reach of scour. They do not now follow this practice. On the contrary, they apparently consider that for ordinary conditions the chief question is bearing power, not scour; they seem to demand a very compelling reason before they accept scour-proof construction as warranted. This is a poor way to save money. However good economy may be in its proper place, there is no economy or profit in constructing shallow bridge foundations.

The time is appropriate to the preceding remark. A little epidemic of washouts characterized the notable high-water period of the past few months. Not only falsework and various kinds of temporary structures, but also permanent piers were scoured out and overthrown. In a mild way the period is a reminder of the 1913 flood days, which in their great list of washed-out bridges presented an utterly disillusionizing revelation of poor bridge-foundation practice.

Two factors are responsible in most cases for the defiance of proper rules of caution in this matter. The first is the example offered by the lucky survival of many poor, shallow, unprotected piers. Such examples constantly speak the argument, "This type of construction is adequate; more costly work is waste of money." The other factor is the very common conscience-soothing justification that the projected bridge is intended to give only a limited length of service. The piers need be made no more enduring than the superstructure, because they are sure to be obsolete when the spans reach the end of their life.

It is the engineer's part to possess enough strength of conviction to resist these two arguments. He is the one whose business it is to recognize their fallaciousness and to plan for sound and secure foundations. He must recognize clearly the facts that many existing structures deserve to have failed long ago and that not every structure is a good model. He must also look a little to experience in bridge renewal, which shows that time after time the superstructure only is renewed, while the piers, if still sound, are retained and by dint of adaptation or reinforcement made to do for a second term of service. He must base his work constantly on the principle that a bridge pier is inherently a thing built to endure.

There are good and bad points in the time-worn preachment that the engineer should do with one dollar what someone else would do with two. A bad point is that it leads some engineers to do all their work on a 50% basis, with an eye to today only. Bridge piers are almost the worst possible subjects for one-dollar engineering.

Give the Bidder Information

One theory of getting low prices in contract letting is that the contractor should be induced to gamble—guess—as blindly as possible. Another theory is that by securing fullest information of working conditions and throwing this open to all bidders the lowest and best bids will be obtained. The City of Dayton, Ohio, has just demonstrated that the second theory is true.

In calling for bids on three concrete-arch bridges the city's engineering department made available to intending bidders unusually complete data on conditions. The state of affairs was so exceptional as to call for comment at the letting, and the editor has received letters complimenting the city on its thorough information service in the case. Thanks was not the only return the city got for its work, however. It got a series of bids with hardpan prices; and when it awarded the contract, it put back into the public treasury many times as much as was spent in getting the information for the bidders.

Besides the money saving there will be further returns to the city on its investment in data. The chances for trouble in carrying out the contract are greatly reduced by making the contractor secure against unpleasant disappointments in the conditions he encounters. When the exploring is done during the carrying out of the work itself, every adverse condition found means either conflict between engineer and contractor or a compromise on lowered quality of work. Full and correct advance information, on the contrary, means absence of trouble and delay and fully maintained quality of work.

Modernizing the Municipal Engineer's Offices

The old-time city engineer's office partook of the slackness and inefficiency of the contemporary municipal government. Usually it was housed in the darkest corner or dampest basement of a drafty city hall in rooms of mammoth proportions and abnormally high ceilings. On entering, one was confronted with a high counter on which reposed dog-eared platbooks and behind which groups of disconsolate "engineers" chewed tobacco and languidly worked, or more often discussed current events and local scandal. The invariable transit, level and rod took up the corner space not occupied by decrepit picks and shovels, specimen paving bricks, broken manhole covers and unbound files of the technical journals.

The picture is not overdrawn. Moreover, the condition persists in more than one good-sized city. And after visiting such an office, one is quite ready to believe that the municipal engineers permitting, or even submitting to, such conditions deserve the disapproval frequently visited upon them by the average citizen. May not the oft-discussed "status of the engineer" be in some way tied up to such unkempt working habits and surroundings?

There is a brighter side to the picture. Just as municipal government is generally becoming more efficient, so the municipal engineering offices are beginning to take on a beneficial modernity. In some cities, such as Jacksonville, the engineering department has a building to itself, designed to meet the specific needs and conducted under a businesslike management. In others, like Dallas, Tex., as described on another page of this issue, parts of the general city offices are equipped and arranged so as to permit the most efficient conduct of the engineering operations of the city. Even where the old quarters must still be occupied, many city engineers are awakening to the necessities of the case and are revising equipment and customs to conform with better practices in the private office.

There can be no doubt that there is a certain deadening influence in municipal work. Anything that tends to improve the working surroundings of the men must improve their morale and increase their efficiency. At the same time the introduction of modern methods and equipment must favorably impress the citizens having business before the department and through them gradually react to raise the city engineer in the estimate of his employers—the people of his city.

Choking an important river down to half its unrestrained flood flow is a rare achievement in the world's history. We are soon to see the beginning of the great works that shall exercise this control over the Miami and the Scioto Rivers. The Miami project is now fully worked out, and except for a few formalities it is ready for the contractor. The Scioto project is not far behind in its progress, although the engineers started on their planning much later. This summer is to see actual work begin on both enterprises. In three years they can be completed, and the flood protection realized.

Congratulations are due the Ohio communities that will pay for the flood-prevention works $35,000,000—a great sum, even though it be only one day's war cost. They are giving the answer to the problems suddenly thrust before them in the disorganization of the state-wide flood calamity just three years ago. At that time they tried in a helpless way to call on state and nation for future protection. State and nation declined to deal with the problem and in effect told them to help themselves. They are doing it.

"There was only a small margin between the flood height reached last week and a substantial repetition of the 1913 disaster," said a prominent engineer in Columbus, Ohio, recently. "Though the flow was only one-third as great as in the big flood, yet with a few feet more rise, enough to reach the top of the levees, the damage done to the West Side would have been practically the same." This statement throws the clearest light on the urgency of flood-protection measures in the Franklin County district. Plans are nearly ready for going ahead with the legal preliminaries to construction, but just at this time some factional opposition is developing, with a promise that there may be serious interference with the project. Columbus citizens need only read the signs of the season to realize where lies their best chance for early accomplishment of flood prevention.

Letters to the Editor

New Orleans Pump Tests

Sir—In the issue of *Engineering News*, Jan. 13, 1916, the article "Testing the 12-Ft. Wood-Nordberg Pump" gives a rather extreme case of fictitious accuracy. In the table giving the summary of tests, page 73 of that issue, the flow is given as ranging from 510.08 to 559.09 cu.ft. per sec. To most engineers who are familiar with stream-measurement methods any computations of stream flow carried to five significant figures will probably seem very refined, to say the least.

It would appear from the probable shape of the vertical velocity curves in a section of the character described in that article that the discharges as obtained would all be high. The weak place in the method used is in the locating of the points for measuring the velocities. Instead of locating these points by the well-known "0.2 and 0.8 depth" method, as developed by the United States Geological Survey, they were taken apparently without any reference to the vertical distribution of velocities. The writer is of the opinion that with the rough method used in finding the velocities the discharges cannot be relied upon to have an accuracy of better than 5%, though they would probably agree among themselves very much more closely, due to the careful setting of the pitot tube for each velocity.

With a probable error of at least 3 or 4%, and perhaps 5%, it hardly seems excusable to give results to five significant figures.

R. C. Pierce.

Purdue University, Lafayette, Ind., Mar. 7, 1916.

[The following comments on the foregoing criticisms have been made by the engineer in charge of the tests in question.—Editor.]

Sir—Mr. Pierce has evidently failed to consider the large number of points at which velocities were taken. Our method is, in effect, the integration method recommended by the United States Geological Survey as better than either the "0.2 and 0.8" or the "0.2, 0.6 and 0.8 method." These methods were discussed before the test, and the method used was adopted as being the fairest. The depth methods were not used on account of the variation in height of cross-section.

After the receipt of Mr. Pierce's criticism, velocity rates in parallel vertical planes perpendicular to the cross-section of the stream were plotted from our data for the case of maximum efficiency. From the curves the velocities at 0.2, 0.6 and 0.8 of the depth were taken, and the volume of water delivered was calculated. There was 1% variation in the results.

The long straight section of the canal in advance of the measuring station tended to iron out the stream lines, and this would tend to vary results obtained by the depth theory.

The results given in the article are the averages of a large number of readings and, as is commonly done, were carried to two decimal places, not that we believed absolute accuracy was obtained, but to enable anyone to check calculations. Every possible refinement was used to obtain correct results. The observers on these tests have been engaged on similar tests and water measurements since 1898 and have reached a large degree of skill, which reduces the personal element to a minimum.

It is generally impossible to give accurate tests of pumps of this magnitude either on account of local conditions or cost. The value of pitot-tube measurements in pipes not running full or taken near the wheel is practically nil.

On the day of the test this pump was handling water from which gas bubbles were rising in great quantities. At high lifts the gas given off in this pump naturally impaired its efficiency. Naturally, no estimate can be made of the amount of loss from this effect.

W. H. P. Creighton, U. S. N. (Retired).

Tulane University, New Orleans, La., Mar. 30, 1916.

Sinking-Fund Delusions

Sir—Referring to your comment on my letter, which you were courteous enough to print in your issue of Mar. 2, 1916, may I make another effort to disclose my position on the question of reserve for renewals? The subject is of such vital importance and is so much misunderstood that a continuation of the discussion seems to be justified.

I cannot agree with you that "the actual loss of capital through 'depreciation' . . . averages $2.50 for each year of the 40." As far as the "physical facts" are concerned, there is no such loss. In fact, the plant may have increased during the year in efficiency or productive value due to well-placed minor expenditures. But we still have to face the fact that days will come when renewals must be made. It may happen that in practice the changes of the year may modify our life estimate. But an estimate must be made to guard against misstatement of net earnings.

"The stated value of the property" should not be changed on the ledger, and certainly not on the score of "capital repaid"; by the sinking-fund method only $1.05 is provided for each year, and even at that it cannot be fairly considered as "capital repaid." You say that the difference between $2.50 and $1.05—namely, "$1.45—must still be recovered from the business in some way." If you charge up the full $2.50 each year, the $1.45 is necessarily "recovered from the business"; but if we charge up only $1.05, the balance of $1.45 does not have to be recovered from the business in any way, because the annual payments of $1.05, together with their earnings in interest take care of the balance of the "recovering." As far as the ledger story is concerned, we have the debit balance of plant account to show the investments as made, and against that we have the liability shown in the credit balance of reserve account.

There is no "capital sacrificed," because the sinking-fund reserve prevents that sacrifice. I come back to

the statement with all possible emphasis that the sinking-fund method of treating renewal reserve is in no sense a "trick in words and bookkeeping'" I hold that the method you indorse would be a trick on the purchasers of service.

ALEX. C. HUMPHREYS,
President, Stevens Institute of Technology.

Hoboken, N. J., Mar. 24, 1916.

Union vs. Identity

Sir—In *Engineering News*, Mar. 23, 1916, Secretary Drayer, of the Committee on Engineering Coöperation, says:

> One thing that stands out clearly in a study of the world's progress in recent years is the tendency to bring together scattered and highly specialized activities into organizations where effort is coördinated to the end that the product of the whole shall be of greater and improved quality with a benefit accruing to both producers and consumers. Whether the product is of the hand or of the brain, this statement holds true.

In curious contrast with this is your eagerness to clear the national engineering societies of any nefarious plot to bring about such a union of these societies that, in the language of a member of the American Society of Civil Engineers, whom you quote:

> Future national or other movements for the benefit of the profession will be headed by the United Engineering Society and our share in the work will be merely auxiliary thereto, the ultimate result of which will be that the influence and standing of the American Society of Civil Engineers, which are now conspicuous, will gradually wane and finally be lost in the controlling organization of which we will become a chapter.

This awful calamity is held up, by the member mentioned, as one of the dire consequences to follow the proposed removal of the American Society of Civil Engineers from its present quarters to the Engineering Societies' Building. Commenting upon this, you say:

> If the charge just quoted were true, there is no question whatever that the proposition now before the members of the American Society of Civil Engineers would be and should be defeated. The society would not and should not sacrifice its independence of action nor give to any other organization authority over it in the conduct of its affairs.

This seems to give color to Secretary Drayer's charge that "engineers are somewhat behind other groups of men in the general movement toward coöperation."

Happily for us all, they are at least something more than a century behind our much abused friends the politicians, who in the eighteenth century succeeded in inducing thirteen separate commonwealths to surrender each its own sovereignty, sacrificing its independence of action and giving another organization authority over it in the conduct of its affairs.

And this, be it remembered, was compassed in the days before the railroad, the steamboat, the telegraph and the telephone had reduced the boundaries of the Union to far less dimensions than those of even little "Rhode Island and Providence Plantations," when men, owing to their isolation from each other, were naturally ignorant of and therefore distrustful of each other, when petty jealousies must have existed between the states, compared with which the shudders of the member mentioned lest "the influence and standing" of his own particular society, "which are now conspicuous, . . . will finally be lost" would appear like broad-minded modernity.

Whatever prospect there may be, in the proposed removal, of closer union between the American Society of Civil Engineers and the founder societies—even to the point of complete merger—is the chief reason for such removal.

It is to be hoped that engineers are not hopelessly old-fashioned and that Secretary Drayer is not over-sanguine when he says:

> Today there is a current, obvious to all, setting in the direction of an organization in which the collective efforts of engineers will be administered for the good of the profession and the public

and not primarily for "the influence and standing" of any single society, however honored.

JOHN C. TRAUTWINE, JR., Assoc. Am. Soc. C. E.
257 South 4th St., Philadelphia, Mar. 27, 1916.

San Diego's City Engineer on the Otay Dam Failure

Sir—Since the writer, as City Engineer of San Diego, has borne more or less of the responsibility for the operation of that city's water system, both prior and subsequent to the recent failure of the Lower Otay dam, it may be of interest to the engineering profession to review some of the information that I have compiled in connection with this failure. I will not attempt a detailed discussion of the matter, because I have not collected sufficient data as yet in regard to several phases of the subject. There have been several articles printed, however, in discussion of this failure, and I desire to correct some of the wrong impressions conveyed by a few of these articles. I realize that all these articles were prepared rather hurriedly, without proper time in which to ascertain all the facts. This is easily excusable, of course, if the proper qualifications are made in regard to figures given, but in several instances the writers of these articles have given figures which are in error and then used them in making deductions which are still farther removed from the fact.

In R. A. Silent's article in *Engineering News*, of Feb. 17, 1916, there are several errors in figures. He gives the maximum capacity of the spillway at the time of failure as 2,100 cu.ft. per sec., whereas it was 4,700 cu.ft. per sec., or approximately double the amount he states. He used some erroneous figures also in regard to dimensions of spillway and depth of water on its crest.

The statement that the area of the Lower Otay watershed was 139 sq.mi. is another error of considerable importance. The area of the watershed directly tributary to the Lower Otay is 85.7 sq.mi. and, adding to that the area of 12.6 sq.mi. which is tributary to the Upper Otay reservoir and which was overflowing into the Lower Otay for a week prior to the failure of the Lower Otay dam, we have a total area of 98.3 sq.mi. of watershed.

The account of the failure of the Lower Otay dam by Francis L. Sellew, of La Jolla, San Diego, published in *Engineering News*, Mar. 9, 1916, is very interesting in view of the fact that Mr. Sellew is a well-known engineer of considerable reputation in connection with his work with the United States Reclamation Service. The writer is surprised, however, that an engineer of Mr. Sellew's standing would attempt a discussion of the responsibility for this failure with so little real knowledge of the actual conditions. Mr. Sellew evidently obtained all his figures and data from some textbooks, such as Wegmann, Schuyler or Turneaure and Russell, and not from actual conditions. I wish to make the following corrections in regard to the figures he has used:

The height of the Lower Otay dam was 135.5 ft. instead of 130 ft., and the spillway was 11 ft. below the crest of the dam instead of 6 ft., as he states. This is of considerable importance in view of the fact that the capacity of the spillway at the time of the failure of the dam was 4,700 cu.ft. per sec., or over two and a half times as great as it was with only 6 ft. depth of water on the crest, as his figures would show.

Second, the slopes of the Lower Otay dam were determined by various measurements and found to be 1¼ to 1 and not, as he states, "probably 1 to 1."

Third, the investigation relative to the "coefficient against sliding," as Mr. Sellew calls it, does not seem to be to the point, in view of the fact that the dam did not eventually fail by sliding on the base.

There is absolutely no question in the writer's mind that the dam would still be standing if the water had not actually reached the top of the fill and flowed over it long enough to remove the support from the downstream side of the core wall. The dam failed from the top down, it did not slide on its base, fail at foundation or overturn.

It is useless to discuss the merits of the design of this type of dam. I do not think any engineer of standing ever approved the design of this dam. It was a hybrid type beyond question.

The failure was due to overtopping because the spillway was of insufficient capacity to take care of an unprecedented flood resulting from a cloudburst. However, I do not think there was an engineer in the country who would have recommended a larger spillway in view of the runoff records prior to the recent storm. I am familiar with several reports made upon the present city system by leading hydraulic engineers who have been called in to consult in connection with the development and capacity of the system, and it has always been the expressed opinion among engineers that it was doubtful if the Lower Otay reservoir would ever be filled from its own watershed, even to the height of the spillway crest, 11 ft. below the top of the dam.

After the first storm of Jan. 17 and 18, the reservoir filled rather rapidly at first and later more gradually, until the water reached the crest of the spillway on Jan. 22 and began to waste at the rate of several million gallons per day. The matter of impounding more water by placing temporary flashboards in the spillway was advocated by E. S. Babcock, the original builder of the dam, and several other prominent citizens, but the writer, together with the mayor, E. M. Capps, M. Am. Soc. C. E., refused to allow any such operation of the dam, and nothing was ever done to try to conserve water in the reservoir above the spillway crest, 11 ft. below the top of the dam.

The rate of runoff into the Lower Otay reservoir was 23,500 cu.ft. per sec. for a period of 1 hr. prior to the failure of the dam, or over seven times as great as any runoff shown by the prior records. The average runoff for the 10 hr. preceding the failure was at the rate of 13,960 cu.ft. per sec., or over four times as great as any prior record shows. Furthermore, the runoff was still over 2,000 cu.ft. per sec. when the writer visited the scene of the failure at 3 p.m., Jan. 28, 1916, just 22 hr. after the dam went out; and it is doubtful if the crest of the flood had reached the reservoir prior to the failure.

There has been some criticism of the operating department because the 36-in. blowoff valve was not opened a few hours earlier. The maximum capacity of the 36-in. blowoff is 330 cu.ft. per sec., and in order to have had any effect upon the ultimate result the gate would have had to be opened wide some time prior to the beginning of the first storm on Jan. 17, 1916, or over 10 days prior to the failure of the dam. Such a procedure would have been looked upon as the act of a lunatic at that time by both engineers and laymen, but taken as a "hindsight," of course it certainly would have been a wise precaution. In fact, I would have been in favor of emptying the reservoir some time last fall and, in addition, enlarging the spillway to about four times its capacity, if we had only known about this storm! It seems too bad that the Almighty does not see fit to inform us a few weeks ahead of time when He sends such a deluge as He visited upon this section on Jan. 27, 1916.

Of all the discussions in regard to this failure, the articles by Lars Jorgensen and Horace W. King, appearing in *Engineering News* of Mar. 9, 1916, are more to the point and more nearly according to the facts than any other articles I have seen.

I am preparing a detailed report, which I hope to be able to present in a paper to the American Society of Civil Engineers (of which Mr. Sellew is a member) some time in the near future, and I hope that Mr. Sellew will be willing to retract some of his statements in regard to inefficient management and acknowledge that the failure of the Lower Otay dam was due to an act of God in sending a deluge that was beyond human possibility to anticipate or cope with.

GEORGE CROMWELL,
San Diego, Calif., Mar. 23, 1916. City Engineer.

Sewers for Snow Disposal

Sir—In your snow-removal article in the Mar. 16 issue of *Engineering News*, you mention sewers for snow disposal. Therein lies the solution of the snow-removal problem. Provision for storm-water removal followed the extended use of sanitary drains, and now a logical sequence is the construction of sewers expressly designed to include snow disposal.

It is going against the natural functions of snow to heap and then cart it away. Present sewers, where they are available for snow disposal, have demonstrated the economy of this method. If we completely eliminate hauling and make the sewer proof against clogging, the cost of disposal with the aid of snow plows would be considerably less than the 3c. per cubic yard you mention.

It is my opinion that all cities where snow disposal is a necessity are confronted with the problem of rebuilding their sewers to include this additional function. The enormous loss sustained after every snowfall, together with the millions of dollars spent on disposal, warrants this reconstruction.

Very rapid snow disposal must be provided for to guard against the danger of resulting slush or ice, and therefore the future sewer will be ready to receive a deliberate charge of snow all along its line, regardless of the density and without the necessity for nursing to eliminate the solid refuse inevitably swept with the snow.

With the danger of clogging eliminated and with heaping and carting unnecessary, the streets before most business buildings would be cleared without waiting for the department to arrive. L. DAVIDSON.

309 Broadway, New York City, Mar. 28, 1916.

News of the Engineering World

Philadelphia Improvements To Cost Over $100,000,000

A bond issue of over $100,000,000 for municipal improvements will probably be submitted to the voters of Philadelphia at the primary election on May 16. The largest item in this amount is $57,100,000 for new rapid-transit lines. Next comes $9,000,000 for the new parkway, or diagonal boulevard, from the City Hall northwest to Fairmont Park, $5,000,000 for port improvements, $5,640,000 for grade-crossing removal in South Philadelphia and $3,200,000 to start work on treatment of the city's sewage before discharge into the Delaware. Other sewer work, water-supply improvements, bridges, parks, paving, etc., increase the total to $108,000,000.

Another Transmission Cable Under San Francisco Bay

A third high-tension electric-power transmission cable has been laid across San Francisco Bay from the Key Route mole to San Francisco, a distance of about 20,000 ft. A large party of prominent engineers witnessed the work of laying, on Mar. 14. The cable contains three conductors, each of 250,000 circ.-mils capacity for the under-water section, connecting to conductors of 300,000 circ.-mils capacity at the shore terminal. Current at a pressure of 100,000 volts is received at a substation in Oakland from the hydro-electric station of the Great Western Power Co. on the Feather River and is stepped down to 11,000 volts' pressure for transmission through the submarine cables.

Each of the three conductors is protected by insulation consisting of $\frac{3}{16}$ in. of 30% rubber and $\frac{1}{16}$ in. of varnished cambric. These three insulated conductors, with a No. 14 rubber-covered twisted pair of wires and jute filler, are formed into a core over which is applied a $\frac{5}{32}$-in. thickness of varnished cambric. The core is then covered with lead, alloyed with 1% tin, to a thickness of $\frac{5}{32}$ in., and around the lead sheathing is wound an armor of No. 4 double galvanized steel wire. The twisted pair of wires in the cable is used for a telephone circuit. In laying this cable no messenger cable was used, the cable itself being relied upon for mechanical strength.

The cable was manufactured by the General Electric Co. and was furnished in lengths of 1,308 ft. The joints between successive lengths were made and wiped with a lead sleeve in the usual manner, and then a pipe sleeve, designed by E. W. Beardsley, General Superintendent of the Great Western Power Co., was slipped over the joint.

The pipe sleeve is made up of two nipples of extra-heavy 4½-in. wrought-iron pipe and a right- and left-hand coupling. Before this pipe sleeve was put on, the lead sheathing of the joint was wrapped in sheet asbestos, which was covered with a layer of asbestos cement. In this way the lead and the cable under it were protected from the heat of the welding process, for after the pipe joint was in place, the armor wires on each side were welded to it with an oxyacetylene torch. After welding, the right- and left-hand coupling was screwed up to tighten the wire connections and relieve the interior of the cable from mechanical stress. The finished length of the armor splice is 30½ in.

Chicago Engineers Studying Military Science

A group of prominent engineers and contractors of Chicago and vicinity have formed a Joint Committee on Military Engineering. The founders are members of all the leading engineering and contracting organizations of Chicago, including the local branches of the national engineering societies. The purposes of the committee are to further military preparedness among engineers, contractors and their associates by the following means: (1) Courses of lectures, (2) assigned reading, (3) practical instruction, (4) assisting engineers to qualify as officers in a national reserve corps of civilian engineers, (5) urging enlistment in and support for engineer troops of the National Guard and such other organizations as the Government may create, (6) training camps and the attendance in them of those qualified, etc.

The joint committee has prepared a program for a period extending from Apr. 20 to July 25. Something of interest will be taken up each week, including lectures by Lieut.-Col. W. B. Judson, Engineer Corps, U. S. A.; lectures by Major P. S. Bond and Lieut.-Col. Mason M. Patrick, Engineer Corps, U. S. A., several exhibition drills, terrain exercises and inspection trips under the direction and guidance of various officers of the engineer troops of the Illinois National Guard. Additions to the program will be made from time to time.

Engineers, contractors and their associates in Chicago and vicinity are invited to join the Joint Committee on Military Engineering. Correspondence should be addressed to the secretary, Robert F. Hall, 111 West Washington St., Chicago.

The directors of the Joint Committee are: Wharton Clay, chairman; Robert W. Hunt, vice-chairman; Robert F. Hall, secretary-treasurer; Bion J. Arnold, W. W. DeBerard, J. De N. Macomb, Jr., H. S. Baker, Robert I. Randolph and Vernon C. Ward, Jr.

Washout of Steel Truss Bridge Across Susquehanna River

Two spans of the three-span steel truss bridge across the Susquehanna River at Athens, Penn., built only two years ago, were washed out on the morning of Sunday, Apr. 2, by the underscouring of one of the river piers. The bridge consisted of three steel spans 183 ft. 4 in. each, with paved roadway of 20 ft. clear width and two 5-ft. concrete sidewalks. It was completed Aug. 22, 1914, costing $39,300 for the superstructure.

This bridge replaced a Burr-truss bridge of considerable age, which was condemned in the summer of 1912. The old masonry work, being found in good condition, was used for the new spans after filling the hollow spaces above the wooden arch bearings and enlarging the piers by reinforced-concrete incasement. The pier repairs cost $8,936, making the total cost of the new bridge $49,236. The Horseheads Construction Co., Horseheads, N. Y., built the masonry work and erected the superstructure, which was fabricated by the Penn Bridge Co. The bridge was opened to traffic Aug. 22, 1914. David A. Keefe, Engineer for Bradford County, was in charge of the work.

Mr. Keefe reports that early on the morning of the collapse, the river being within 2 ft. of extreme high water, he received news that there had been scour in the river just below one of the old piers. The pier was then observed to have a settlement of 15 in. on the downstream side, and the bridge was closed to traffic. Within the next hour, the settlement increased, until the span slid off into the river. The pier turned over two or three times and completely buried itself in a large hole about 100 ft. downstream. One of the spans rests on the river bottom, right side up and intact. The middle span is turned upside down. It is expected that there will be considerable salvage of the steel.

Pier 2, the one washed out, was in 8 to 10 ft. low-water depth (1912 surveys). Its foundation, resting in fine gravel 13 ft. below low water, or 3.20 ft. below the lowest point of the bed, was a timber crib 15x36 ft. by 12 ft. deep, filled with stone. In 1885 the upstream nose underscoured, and thereafter 18-ft. protection piles were driven around the piers 3 ft. on centers and riprapped with heavy stone at 2½ to 1 slope. From then until last week the pier has given no trouble. A gravel bar formed in the channel about 300 ft. downstream of Pier 1, and this shifted the main current to the west. Mr. Keefe believes this change of conditions responsible for the deep scouring—over 40 ft. below low water.

A temporary trestle will be built across the river to carry traffic now and serve later for handling materials to the new pier and for supporting the new spans during erection.

Progress Toward Rapid Transit in Philadelphia

The start toward a comprehensive rapid-transit system in Philadelphia was made in 1912, when Mayor Blankenburg appointed A. M. Taylor as Transit Commissioner to investigate the problem and recommend ways and means of solution (although for a number of years there has been in operation in Philadelphia an east and west rapid-transit line consisting of a two- and four-track subway under Market St. from the Delaware River to the Schuylkill, connecting with a two-track elevated railway on Market St., in West Philadelphia, the whole line being some five miles in length). In 1913 the first broad plans were reported, and Mr. Taylor became the Director of the newly created Department of City Transit.

The plans, as finally modified in 1915, provided five radial subway-elevated lines to the outlying districts—northeast to Frankford, north to Olney, northwest to Schuylkill Falls, southwest to Darby and south to League Island. The Frankford and Darby lines were designed to come into the existing subway, and the Olney, Schuylkill and League Island lines to a big loop in the business district; later the Darby and Frankford lines were to be connected by a Chestnut St. subway. These lines were to cost the city $63,500,000 and the lessee $15,206,000. The lessee (expected to be the Philadelphia Rapid Transit Co.) was to secure 6% on its investment, to be protected against diversion of present traffic and to have taxes abated. A deficit to the city of $21,284,000 up to 1930 was expected, when the lines would become paying and give transfers to all intersecting lines. The Frankford line was to go into operation in 1918, the Darby line in 1919, the north and south lines and the loop in 1920, the northwest line in 1923.

The lines did not appear to be attractive to private capital, and financing was made possible by an amendment to the city charter enabling the city to issue bonds up to 3% of the assessed valuation for rapid-transit improvements without inclusion in the debt limit. In 1915 a $6,000,000 bond issue was voted by the Councils and approved by popular vote, to provide for initial construction—the elevated railway to Frankford and the first section of the north and south subway lines on Broad St. The steelwork for the elevated line is fabricated, and erection is about to begin. The contract for a section of the subway at City Hall has been let, ground was broken last fall, and about $10,000 worth of work has been done.

The change in the city administration on Jan. 1, with the strife between different political factions representing, according to current report, rival contracting firms, has brought some uncertainty into the situation. The new Director of the Department of City Transit, W. S. Twining (a prominent engineer who has been connected with Philadelphia transportation problems for years and who for the last three years has represented the department's consulting engineers, Ford, Bacon & Davis) recommended some comparatively minor changes in the engineering plans and advocated undertaking construction in much slower steps—on account of the high prices prevailing and because the facilities would be beyond the real needs for many years. All the radial lines were approved, but the central-district loop was discarded as being too expensive for the benefits and as tending to increase the number of pedestrians in the already congested vicinity of City Hall. Two of the four tracks under North Broad St. were diverted to the east down an oblique street (Ridge Ave.) and around through the business district in place of the loop; eventually these two tracks would be continued as the radial line to the northwest.

Some difference of opinion has arisen as to the wisdom or safety of carrying the subway directly under the City Hall, as is provided by the contract now let. The City Hall, started 44 years ago, is a massive stone building, five to seven stories high, and great care and expense will be required in underpinning to prevent cracking the walls in carrying the subway tunnels beneath it. In the excavations already made by the contractor, moreover, it has been found that some of the foundation walls are of dry rubble laid wholly without mortar. For safety and economy Director Twining has favored a revision of the location of the tunnels so that they would pass under only one corner of the building, thus reducing the amount of underpinning. The matter was referred to a board of engineers made up of G. E. Datesman, Director of

Public Works; G. S. Webster, Director of Wharves, Docks and Ferries; and C. E. Albright, Chief of the Bureau of Surveys. They favored the change.

A bill approved by the Councils' Finance Committee on Apr. 3 provides $57,100,000 for new subway lines, specifying in detail the several features of the 1915 plans in spite of the modifications recommended by Mr. Twining. The Councils have power to dictate routes and plans to the mayor and the Transit Department; present indications are that the bill as prepared will pass the Councils and be approved by the public on May 16.

Maryland To Spend Over Two Millions on Roads

The Maryland legislature, which has just adjourned, appropriated $2,300,000 for the State Highway Department. It also appropriated $300,000 for county-road construction, of which the state pays 50%, the county 40% and abutting property owners 10%. For use in road maintenance the Highway Department has the proceeds from automobile licenses, now amounting to about $600,000 per annum, which is believed to be sufficient to maintain the state roads already built. A large part of the state appropriation will be spent for bridge construction. There are many bridges across tidal estuaries in the seashore counties of the state which require rebuilding for automobile traffic.

Minnesota Road Improvements

Road improvements in Minnesota during the year 1916 will cost about $8,000,000. Besides an estimate of $1,500,000 from the one-mill tax and from automobile taxation, of which 20%, or $300,000, must be used for maintenance, the county road and bridge tax will yield $2,753,451. The townships will probably raise about the same total as last year, or $3,200,000, and Winona County (of which Winona is the county seat) plans to raise $500,000 by a bond issue for roads and bridges, including 5½ mi. of concrete roads and five concrete bridges. About $4,000,000 of the $8,000,000 will be expended under the supervision of the State Highway Commission, of which George W. Cooley, state engineer, is secretary. This sum will be divided as follows: Grading and graveling and permanent roads, $2,728,500; maintenance of 12,000 mi. of roads, $600,000; new bridges, $700,000.

Reports from 69 of the 86 counties of the state and estimates for the other 17 counties show 1,945 mi. of grading and 705 mi. of graveling projected, besides 1,823 reinforced-concrete culverts, 1,000 small culverts of corrugated metal and 360 bridges.

State-aid road construction during 1915 included as its main items the following; Turnpiking, 378 mi., at a cost of $101,569; grading, 546 mi., at a cost of $625,426; graveling, 361 mi., costing $299,866; concrete culverts, 785 in all, totalling 21,460 ft. in length and costing $83,561; additional culverts of corrugated metal to the extent of 57,029 lin.ft., costing $53,078; 106 bridges of a total length of 4,489 ft., at a cost of $188,451. Other and minor items brought the total state expenditure for construction in 1915 up to $1,469,822. Besides this, $464,000 was expended by the state in maintaining 9,983 mi. of roads. Other road expenditures by the state in 1915 brought the total up to about $2,500,000.

Of the 12,300 mi. of designated state roads in Minnesota a total of 1,414 mi. has been brought to permanent grade, with a standard width of 24 ft., and provided with a first-class surfacing of gravel, macadam or concrete. In addition, 785 mi. of these state roads is graveled, but not to standard, and 2,590 mi. has been brought to final grade line and standard width, but not yet graveled.

Fire Loss at Paris, Tex., Exceeds $10,000,000

The recent disastrous fire at Paris, Tex. (population in 1910, 11,269), has been investigated by S. W. English, State Fire Marshal, and in his report submitted to the State Fire Insurance Commission he says that the property loss is variously estimated at from $10,000,000 to $14,000,000.

The fire had its origin (Mar. 21) in a frame warehouse, and blown by a 35-mi. wind, the flames spread

FIRE HYDRANT WITH CAPS DROPPED AWAY ON ACCOUNT OF HEAT OF PARIS (TEX.) CONFLAGRATION

rapidly until the fire covered an area of 264 acres. In all, 1,440 buildings were destroyed, 1,051 of which had combustible roofs. Frame buildings or iron-clad buildings numbered 1,297, or 90% of the total number of buildings destroyed.

The fire marshal states that the most important lesson to be drawn is the hazard of the shingle roof. The burning of the business district of Paris was not due to lack of fire fighters, nor to lack of water, nor to the type of construction of the business district itself, but was attributable to the shingle roofs of the residence section.

Another lesson that may be drawn is one in connection with so-called "fireproof construction." The Gibraltar Hotel, the First National Bank Building and the post office are striking examples of the disastrous consequences of using combustible material in finishing fireproof buildings and the folly of attempting to save money in the use of inferior materials with the hope that they will withstand the test of fire. The conflagration presents another instance showing that there is no such thing as absolutely fireproof construction and that, when sufficient heat is applied to any kind of known material used in such buildings, serious damage, if not total destruc-

tion, will follow. It is a noticeable fact that in every case where exposed wall openings were protected by wire-glass the progress of the fire was effectually blocked.

The intense heat, even in the street, is evidenced by the view, which shows a fire hydrant with all three of its threaded outlet, or hose, caps melted loose and dropped away. This hydrant was located on a street corner and was about 8 ft. from the brick walls of a building.

St. Louis Engineers Ask Light on Engineering Building

Light on the dark side of the proposition for the American Society of Civil Engineers to move into the Engineering Societies Building, New York City, is desired by the St. Louis association of members of the society named. This desire is thus expressed in a resolution adopted on Apr. 3:

Be it Resolved, That it is the sense of this meeting that the "communication from the Board of Direction of the American Society of Civil Engineers to the membership in the matter of an invitation" from the United Engineering Society to a joint ownership and occupancy of the Engineering Building on 39th St. sets forth in adequate terms the advantages of accepting the invitation, but does not include the objections thereto.

In the opinion of many of the members of this association the negative side of the question should have been stated with equal frankness and fullness, in order that those members who are not familiar with the advantages or disadvantages of the proposed merger and its influence on the future of the society might have full and accurate information on which to base their judgment in order to vote intelligently on the question.

We heartily commend the president of our association, J. A. Ockerson, who, acting solely from a desire to have all phases of this important question put before the members of the society, has given expression to some of the objections to the proposed merger.

We have the utmost confidence in his loyalty to the American Society of Civil Engineers and to the engineering profession in general, which has been proved by many years of earnest work in their behalf, and we hope and believe that he will always use his best efforts for the good of the society.

Gurdon G. Black, 4961 McPherson Ave., St. Louis, Mo., is secretary of the St. Louis association.

Central Municipal Repair Plant Proposed for New York

A bill has been introduced in the State Legislature of New York providing for the consolidation of 71 repair shops now operated separately by the several departments of New York City. The bill stipulates that the consolidated repair shop shall be in the Department of Plant and Structures, which is to take the place of the present Department of Bridges, and gives the Board of Estimate and Apportionment power to transfer repair work in various boroughs to the central shop. The suggestion for this consolidation was made in the annual report of the fire commissioner to the mayor, and the former was instructed to report upon the practicability of the scheme. The report included the following:

This consolidation should include not only the repair shops and their mechanical forces, but also the floating groups of carpenters, plumbers and other mechanics who make repairs to buildings, bridges, park structures and the like. The present method of handling repair work is necessarily wasteful and unbusinesslike. Fourteen different commissioners now control the 71 repair shops. Many of these shops do the same kind of repair work; the shops are scattered haphazard about the city, and few of them are suitably housed or equipped. Each shop is operated as independently of the others as if it were a private plant. Each has its own machinery, its own mechanical force and its own electrical force.

Necessarily there is much duplication in such a system. If the repair work of all these departments were treated as a whole and the force combined, a reduction of at least 25% in personnel would be possible. In addition to this, much of the machinery could be eliminated, all the machinery in the new shop and all repair supplies standardized, purchases consolidated and the stock of supplies greatly reduced and the whole service coördinated and made vastly more efficient.

Cost of operation of such a central plant has been estimated at $2,987,868.92 by the chief of the bureau of repairs and supplies of the Fire Department. This represents a saving of $1,034,526 per year. It is believed that the total volume of repair work now done can be handled by 2,348 mechanics and 155 clerks. The fire commissioner recommends that the reduction in personnel be made not by dismissal, but by dropping out unnecessary positions as they fall vacant through death, resignation, retirement or dismissal on charges. He states that "such a reduction could very quickly be made, as the experience of this department has proved."

The head of the proposed new Department of Plant and Structures will have control over the management and maintenance of the New York and Brooklyn Bridge; the operation of the railroad of the New York and Brooklyn Bridge; the collection of fares and of tolls on the New York and Brooklyn Bridge; and the construction, repair, maintenance and management of all other bridges.

Celebrating the Centennial of the U. S. Coast Survey

The hundredth anniversary of the beginning of work by the United States Coast and Geodetic Survey was celebrated at Washington, Apr. 5 and 6, with appropriate exercises. The bill establishing the Coast Survey was enacted by Congress in 1807, but actual work did not begin until after the conclusion of the War of 1812. In the administration of Thomas Jefferson the merchant shipping of the United States was just beginning its rapid development that continued until the outbreak of the Civil War, half a century later. The need of charts depicting harbor channels and safe sailing courses in the coasts was very great. President Jefferson himself selected the founder and first Superintendent of the Coast Survey, F. R. Hassler, a Swiss scientist of eminence, who when he came to the United States brought with him a collection of scientific instruments and a library of 3,000 volumes.

The exercises in commemoration of the centennial were held in the auditorium of the National Academy of Sciences on Wednesday afternoon and evening and Thursday afternoon and consisted of addresses by prominent scientists, engineers and Government officials. The Superintendent of the Survey, Dr. E. Lester Jones, presided, and the speakers included Dr. Hugh Smith, of the Fisheries Bureau; Dr. Louis A. Bauer, Director of the Department of Terrestrial Magnetism of the Carnegie Institution; Dr. S. W. Stratton, of the Bureau of Standards; Dr. George Otis Smith, of the United States Geological Survey; Gen. William M. Black, Chief of Engineers; George R. Putnam, of the Bureau of Lighthouses; Prof. William H. Burger, of Northwestern University; Rear-Admiral Richard Wainwright, U. S. N.; Dr. O. H. Tittman, former Superintendent of the Coast Survey, and others.

The addresses were chiefly a review of the results accomplished by the survey in various fields of scientific

endeavor and the relation of its work to that done by other Federal bureaus. A very interesting exhibit of apparatus and methods used by the survey was a feature of the celebration. Some of the survey's earliest instruments were shown, and the contrast between these large and unwieldy affairs, better suited to the fixed observatory than to the work of the field, and the compact, easily portable instruments of the present day was most striking.

The culminating feature of the celebration was a dinner given at the New Willard on Thursday evening, at which the guest of honor and the speakers were the President of the United States, the Secretary of Commerce, the Secretary of the Navy, the Minister from Switzerland to the United States and Dr. Thomas C. Mendenhall, former Superintendent of the Coast Survey. Those in attendance at the dinner included representatives of the principal Government scientific and engineering departments. Among the ladies who were present to hear the after-dinner speeches was Mrs. M. C. Hassler Newcomb, a granddaughter of F. R. Hassler, the first Superintendent of the Coast Survey.

Secretary Redfield in his address set forth the great need of modern apparatus and vessels with which to conduct the hydrographic work of the survey and emphasized the great value of the wire drag in discovering uncharted obstructions. Dr. Mendenhall in his address gave a discriminating review of the history of the bureau under its successive superintendents. He related the anecdote of Hassler's conversation with President Jefferson at the time of his appointment. When Hassler named the salary he should expect to receive as Superintendent of the Coast Survey (and which he finally did receive), President Jefferson said, "Why, Mr. Hassler, that is as large a salary as your superior officer, the Secretary of the Treasury, receives." "Mr. President," said Hassler, "any President can make a Secretary of the Treasury, but only God Almighty can make a Hassler."

President Wilson in his remarks referred to his intimate association with men of science and said: "There is something intensely appealing to the imagination in the intellectual ardor that men bestow upon scientific inquiry. It is one of the few pursuits in life which gets all its momentum from pure intellectual ardor, from a love of finding out what the truth is, regardless of all human circumstances, as if the mind wished to put itself into intimate communication with the mind of the Almighty itself."

Upper Mississippi in Flood

Serious flood conditions now prevalent in Minnesota are attributed to the drainage systems that are being constructed in various parts of the state. The Minnesota River, tributary to the Mississippi, the Mississippi River and the Red River of the North are in flood condition at the present time. Formerly the melting snow was held on the land for some time; now it is carried at once to some stream by drainage ditch or tile system and presents a serious problem. The accompanying view shows the high water at the Federal lock and dam being built in the Mississippi River between St. Paul and Minneapolis.

This is the worst flood the coffer-dam has had to withstand and was coupled with 10,000,000 ft. of logs which broke loose from a boom near Anoka, above Minneapolis, and passed through the temporary spillway and over the coffer-dam about 3 a.m., Thursday morning, Apr. 6. About 1,000,000 ft. of logs are lodged against the coffer-dam (Apr. 7). On account of the extreme high water in the Minnesota River, which flows into the Mississippi just below the dam, the head at the coffer-dam has probably not been over 8 ft. The only known damage is the destruction of the construction trestle over the spillway from the west side of the river to the coffer-dam.

LOOKING ACROSS THE MISSISSIPPI AT HIGH DAM NEAR ST. PAUL ON APR. 6

High Water Undermines Bridge Abutments at Alpena

By Joseph McNeil*

Record high water in the Thunder Bay River at Alpena, Mich., washed out one of the abutments of the 9th St. bridge on Apr. 2 and dropped the one span into the river. The bridge is a steel structure of about 113-ft. span, 18-ft. roadway, with 4½-ft. sidewalks on each side,

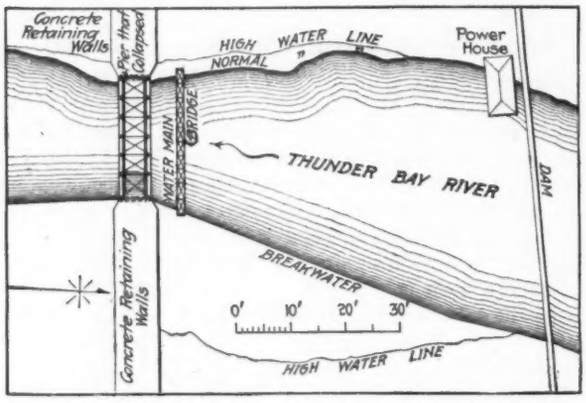


FIG. 1. LOCATION DIAGRAM OF ALPENA BRIDGES

making the entire bridge about 27 ft. in width. It was built by the Smith Bridge Co., but the city built the abutments. The bridge approaches, or concrete retaining walls, as shown in the photographs, were constructed by the city about six years ago. The abutments were built in 1889 of Alpena limestone laid in portland-cement mortar and are approximately 12 ft. in height, 5x28 ft. in base section and 3x28 ft. at the top. The bridge is about 300 ft. below a power dam and consequently spans the swift water of the tailrace. The river runs south; and the abutment on the east side, which is still intact, was built on a rock foundation about 5 ft. under low water at that time, while the abutment on the west side of the river was built on clay and gravel (hardpan) with the base about 2 ft. below low water (Fig. 2). From the center of the river the rock seems to dip west and is considerably lower than on the east side. It was thought unnecessary at the time to construct a coffer-dam or to carry the abutment down to rock.

The water in the river when the bridge went down was about 5 ft. above normal and probably 2½ ft. higher than ever before. The steel-girder bridge of the Detroit & Mackinac Ry. is only about 300 ft. above the power dam, and in order to keep the water below the base of these girders all the gates in the dam were opened.

The formation on the east side of the river directly below the dam is limestone rock, and a breakwater had been built on this side from the dam down to the bridge. This breakwater runs nearly southwest and consequently has a tendency to force the largest volume of water to the west side of the tailrace and toward the west abutment of the bridge. When the water reached its highest point some time Sunday morning, Apr. 2, the bank commenced to wash away on the west side; and the current washed the clay and gravel around from under

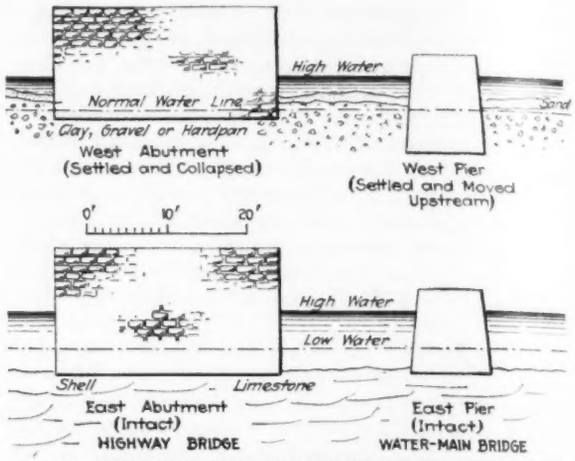
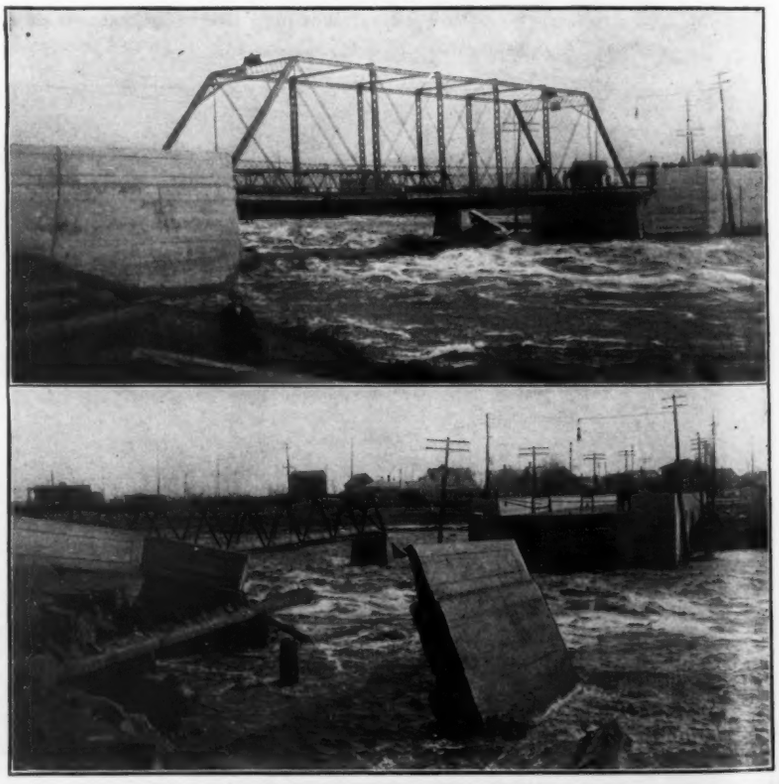


FIG. 2. SECTIONS SHOWING FOUNDATION CONDITIONS

the base of the bridge abutment. It soon began to settle and then dropped nearly vertically for about 2 ft. before toppling over after some of the large stones near the base had become loosened and dropped out.

A small steel-truss bridge supporting a water-main situated 25 ft. north, or upstream, and parallel with the washed-out bridge was erected in 1914. It is 6 ft. in



FIGS. 3 AND 4. ALPENA BRIDGE BEFORE AND AFTER COLLAPSE

*City Engineer, Alpena, Mich.

width, with a span of 137 ft. 6 in., the concrete pier on the west side of the river being set farther back in the bank than the main bridge pier. Both piers for this bridge were built of concrete, the one on the east side of the river being set only a little below low water on a sort of shell limestone formation. The pier on the west side of the river was placed about 6 ft. below low water in clay and stone, or hardpan. Each of these piers has a base of 6x10 ft. tapering to 3x8 ft. at the top (Fig. 2). The pier on the east side remains intact, while that on the west side has settled about 2 ft., turned slightly upstream and moved about 3 ft. in that direction. The shifting of this bridge severed the water main, which had to be shut off at this point for the present.

In Fig. 3, taken about 10 a.m. Sunday, may be seen vertical crack in the concrete retaining wall, which started when the abutment commenced to settle.

Hetch Hetchy Work in 1916

The 1916 program for construction work on the new gravity water-supply for San Francisco is outlined as follows in a report just submitted by M. M. O'Shaughnessy, city engineer:

During the present year the chief works contemplated are the construction of the Hetch Hetchy R.R., for which the contract has already been awarded; the completion of the diversion tunnel and diversion dam; preparation of the foundations for the main Hetch Hetchy dam; preparation for the construction of a temporary power plant to supply electric current for the construction operations at the dam site; exploration borings by diamond drilling to determine the character of the formation through which the aqueduct tunnels will pass; the completion of the contract for clearing the reservoir; the continuation of the aqueduct tunnel from Early Intake toward South Fork; additional road and trail construction around Hetch Hetchy reservoir and the continuation of hydrographic, meteorological and survey work as well as the protection of the city's water rights in and adjacent to the valley, including surveys, location and purchase of aqueduct right-of-way across San Joaquin Valley.

It is deemed inadvisable to undertake any of the other heavy construction on this project until the completion of the railroad line.

A Floating Dry Dock of timber construction is being built by the Union Iron Works, San Francisco, Calif., for use at the ship-repair yard operated by this firm. It will be 450x100 ft., with sides 30 ft. high above the floor, and will have a lifting capacity of 7,500 tons.

The Largest Railway Carload, in combined weight and size, is reported in a shipment on Apr. 7 from the Greenville, N. J., yards of the Pennsylvania R.R. This was the 8,000-kw. generator of a steam-turbine power unit; it weighed 80 tons and on its car stood 15 ft. 7½ in. above the rails. The generator was purchased by H. L. Doherty & Co. from the Brooklyn Edison Co. for use in Joplin, Mo., by the Empire District Electric Co. The Pennsylvania was the only road that would haul the machine assembled. It had recently built a flat-car, rated at 70 tons, that could be used. The generator was taken by boat from the South Brooklyn plant of the Edison Co. to the railway transfer yard. The railroad has mapped a special routing necessary because of clearance obstacles. The turbine transaction was made because of the inability of the manufacturers to deliver a unit in less than a year.

Municipal Ownership of the Water-Works supplying Oakland and adjacent communities appears to have been advanced by a ruling of the California Railroad Commission. The works are owned by the Peoples Water Co., Oakland, which has offered to sell them either to Oakland or else to a water district for $14,100,000—a price fixed by the Railroad Commission. The company also has a reorganization scheme before the commission for approval, providing for the transfer of its property to the East Bay Water Co., the latter to pay for the property by an issue of $9,128,000 of 5½% bonds, $7,400,000 of 6% preferred stock and $600,000 common stock. The commission has approved the proposed securities, except the common stock. At the same time the commission urges the municipalities concerned to buy out the company and calls upon the company, in case the works are not taken over by the cities, to submit a comprehensive plan for an enlarged water service to Oakland and vicinity.

Philadelphia Civic Exposition—What is called a "Philadelphia Today and Tomorrow Civic Exposition" is scheduled to be held May 15 to June 10 in the Auditorium building of the Philadelphia Commercial Museum. The Exposition Committee states that it is working for a cleaner, healthier, more convenient and more beautiful city, and all the citizens are urged to lend their aid at least to the extent of subscribing for a season ticket admitting two, which costs $10. There will be no charge for space (except for commercial exhibits), but each organization will pay for the cost of preparing and installing its own display and a fee of $25 toward the executive expenses. The central exhibit will be that of The City of Philadelphia, and it is intended to show what the city administration is doing for the city. There will be five departments of exhibits: The visible city, education and social, economics, commercial and attractions. The director is Albert R. Rogers, and the headquarters are at 734 Widener Building.

Closure of 790-Ft. Span, Harahan Bridge—The Tennessee channel span of the Harahan bridge over the Mississippi River at Memphis, Tenn., which is being constructed for the Rock Island, Iron Mountain and Cotton Belt railroads by the Pennsylvania Steel Co., was closed on Apr. 5. The 790-ft. length of the span contains a 418-ft. suspended span and 186-ft. cantilever arms from the 621-ft. fixed span in the middle of the bridge and from the shore anchor arm. It was built by cantilevering out from the ends. Closure was made at the middle of the suspended span. Following the completion of this part of the work, the travelers were moved to the 604-ft. span at the Arkansas shore, where the falsework was carried out by high water in December ("Engineering News," Jan. 6, 1916, p. 43, and Jan. 27, p. 197). The larger part of this span will be erected on falsework. The closure was witnessed by members of the Nashville Section of the Engineering Association of the South, who were brought to Memphis on a special train as guests of John Howe Peyton, president of the Nashville, Chattanooga & St. Louis Ry., who is also president of the Nashville organization.

Joint Sewage-Treatment Works for Pasadena, South Pasadena and Alhambra, Calif., were recommended on Mar. 27 by the Board of Engineers of Sewage Disposal created about a year ago under a contract signed by the three cities. To provide an effluent that may be used on a new sewage farm, land for which has already been acquired, or that may be bypassed when irrigation cannot be practiced, a well classified nonputrefiable effluent is deemed necessary. The plans provide for Imhoff clarification tanks, sprinkling filters, secondary Imhoff tanks for final sedimentation and sludge-drying beds. The estimated cost of a joint outlet sewer and of the proposed work, exclusive of the sewage farm, is about $320,000, to be met two-thirds by Pasadena and one-sixth each by the other two cities. The sewer farm is already owned on the basis just stated, and maintenance costs of the whole project, as well as the division of revenues, will follow the same plan. A carefully written, detailed illustrated report on the project has been issued by the board already named, which is composed of the city engineers of the three cities, as follows: R. V. Orbison (president), Pasadena; Charles E. Hemes (secretary), Alhambra; John MacMillan, South Pasadena.

PERSONALS

Mr. M. D. Franey has resigned as Master Mechanic of the New York Central R.R., at Elkhart, Ind., to enter the employ of the American Brake Shoe and Foundry Co., Erie, Penn.

Mr. W. C. Goss, Engineer in Charge of Sewer Design, Cleveland, Ohio, has resigned to become Sales Engineer of the American Sewer Pipe Co., with offices at 1438 Schofield Building, Cleveland.

Mr. E. H. Heinrichs, formerly in the employ of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, Penn., is now connected with the Union Switch and Signal Co., Swissvale, Penn.

Mr. J. T. Flavin, Master Mechanic of the New York Central R.R., at Gibson, Ind., has been appointed Master Mechanic at Elkhart, Ind., succeeding Mr. M. D. Franey. Mr. Flavin will have charge of the fourth district of the road.

Mr. Monroe R. Hull, M. Am. Soc. M. E., has resigned as Superintendent of Construction at the Washoe Reduction Works of the Anaconda Copper Mining Co., Anaconda, Mont., to become Chief Engineer of the Arizona Copper Co., with hearquarters at Clifton, Ariz.

Mr. W. O. Kennington, Assistant Chief Engineer of the Remy Electric Co., Anderson, Ind., expects to go to England in the near future to act as consulting engineer for the company's European agent, Mr. Walter H. Johnson. Mr. Kennington has also offered his services to the British war office.

Mr. Rudolph P. Miller, M. Am. Soc. C. E., has been retained by the Building Committee of the Board of Aldermen of New York City for the purpose of revising the article of the Code of Ordinances dealing with theaters. Mr. Miller served as expert of the Building Committee of the former Board of Aldermen in its revision of the New York City Building Code.

Mr. E. S. Entwisle, of the Sparrows Point plant of the Maryland Steel Co., has been made Mechanical Engineer in charge of the Maintenance Department of the Steelton, Penn., plant of the Pennsylvania Steel Co., recently acquired by the Bethlehem Steel Co. The position has been created for Mr. Entwisle, who will have charge of all the new construction and repair work.

Mr. Percy H. Wilson, M. Am. Soc. C. E., who from 1908 to 1915 was Secretary of the Association of American Portland Cement Manufacturers, has opened an office for consulting work at Land Title Building, Philadelphia, Penn., where he will specialize in cement, concrete, concrete roads, dredging, foundations, engineering publicity, cost accounting and commercial organization.

Mr. George W. White, County Surveyor of Jefferson County, Tex., has been appointed road engineer in full charge of the building of new highways in that county, for which work over $200,000 has been derived from a recent bond issue. He will have jurisdiction over the preparation of plans and specifications, the selection of materials and the designation of the location of bridges and culverts to be built.

Mr. Nelson E. Frissell, Jun. Am. Soc. C. E., formerly sanitary engineer in the New Jersey State Department of Health, is President of the newly organized Frissell Engineering and Contracting Co., with offices in the Gardner Associates Building, Gardner, Mass. The company will conduct a general civil and sanitary engineering and contracting business and will make a specialty of the sale of tested sand and gravel.

Mr. Lewis Ketchum Silcox, recently Mechanical Engineer of the Canadian Northern Ry., has been appointed Mechanical Engineer of the Illinois Central R.R., in charge of car work. Mr. Silcox was in the service of the New York Central R.R. for several years, entering the company's High Bridge shops in 1903. In 1906 he left to go with the McSherry Manufacturing Co. at Middletown, Ohio, of which concern he was finally made Assistant Shop Superintendent. In 1909 Mr. Silcox entered the employ of the Canadian Car and Foundry Co. as Shop Engineer at Montreal and three years later resigned to go with the Canadian Northern.

Mr. Richard W. Rea, Assoc. M. Am. Soc. C. E., has resigned as Chief Engineer of the Coast Culvert and Flume Co., Portland, Ore., to open an office at 412 Spalding Building in that city. He will specialize in the investigation, design and construction of municipal water-supply, irrigation and drainage works. During 1912 Mr. Rea was Assistant Engineer on the final location and design of the $5,000,000 Kittitas "High-line" canal project and for the two years following was Chief Engineer for the Cascade Irrigation District, at Ellensburg, Wash. He has recently been appointed Project Engineer for the Ochoco Irrigation District at Prineville, Ore., and is about to start work on the final surveys for the construction of the canal system. It is estimated that the project will cost about $800,000. Mr. Rea's headquarters on this work will be at Prineville, Ore.

Mr. Ezra B. Whitman, M. Am. Soc. C. E., has joined the firm of Norton & Bird, Chicago. The new firm, under the name of Norton, Bird & Whitman, will now conduct offices at Chicago and at Baltimore, the latter office being in charge of Mr. Whitman. The firm has been engaged mainly in electric rate cases and other valuation work and will specialize in valuation and rate work and in general municipal engineering, with particular reference to water and sewerage work, hydraulic and water-power engineering and the design and construction of power plants. Mr. Whitman was engineer in charge of the design and construction of disposal plants for the sewerage commission of Baltimore, and upon the completion of that work he became water engineer and president of the water board of Baltimore. On May 1, 1914, he resigned as water engineer for the purpose of entering general practice and became a partner in the Baltimore firm of Greiner & Whitman. William J. Norton from 1907 till 1911 was first assistant secretary of the Public Service Commission of New York City. Paul P. Bird has been steam engineer for the Illinois Steel Co., smoke inspector for the City of Chicago and special power engineer for the Commonwealth Edison Co. of Chicago. All three members of the firm are graduates of Cornell University.

Messrs. E. H. Fitzhugh and Charles J. Crowley have organized the Fitzhugh-Crowley Corporation, with offices at 60 Broadway, New York City. The firm will engage in business as engineers, constructors and railway specialists. Mr. Fitzhugh will serve as president. In 1873 Mr. Fitzhugh entered the service of the St. Louis, Kansas City & Northern Ry. After serving with various railways, including the Wabash R.R., he became assistant to Charles M. Hays, of the Grand Trunk Ry. Later he was President and General Manager of the Central Vermont Ry., in which office he remained until about a year ago. Mr. Crowley, who served as division engineer with Mr. Fitzhugh on the Grand Trunk Ry. during the reorganization of that system, has had a varied experience in railway location, construction and maintenance, as well as the revision of terminal and grade and grade separation. He served as Resident Manager of Construction of the McAdoo tunnels while employed by Jacobs & Davies, Consulting Engineers, New York City, and was also Superintendent and Engineer of the construction of Hale's Bar dam in the Tennessee River. Later he was Superintendent Engineer on the subway connecting the Fourth Avenue Subway, Brooklyn, with the Coney Island tracks of the Brooklyn Rapid Transit at 38th St., Brooklyn. Mr. Crowley is Vice-President and Chief Engineer of the new concern.

OBITUARY

D. D. Dunn, a prominent civil engineer of Macon, Ga., died at his home there on Mar. 20, at 72 years of age. Mr. Dunn was the builder of the Macon, Dublin & Savannah R.R. bridge across the Ocmulgee River near Macon, which was completed two years ago.

James Daniels, Resident Engineer of the United States Cast Iron Pipe and Foundry Co., at St. Louis, Mo., died at his home in that city on Mar. 30. He was born in Herefordshire, England, in 1846. Mr. Daniels was Secretary and Treasurer of the Shickle, Harrison & Howard Iron Co., and since 1901, at which time that company was absorbed by the United States Cast Iron Pipe and Foundry Co., he has been Resident Engineer at St. Louis. Mr. Daniels supervised the building of the Grand Ave. and Reservoir Park water towers in that city. He was 69 years of age.

Dewitt C. Smith, well known in railroad circles, died at his home at Lake Mahopac, N. Y., on Mar. 30. Mr. Smith was a graduate of Yale University, class of 1886. For many years he specialized in railroad development. He represented a syndicate which, in 1898, purchased the Seaboard Air Line Ry., and he was instrumental in effecting the amalgamation of several Southern lines with that railway. He was at one time President of the Richmond, Petersburg & Carolina R.R. In later years Mr. Smith became interested in the oil industry and various other commercial activities and was one of the founders of the Colonial Construction Works, New York City. He was born at St. Vincent, N. Y., 58 years ago.

Harry Clary Jones, Professor of Physical Chemistry at Johns Hopkins University, died suddenly at his home in Baltimore, Md., on Apr. 9. He was born in New London, Md., in 1865. He received the degree of doctor of philosophy from Johns Hopkins in 1892 and spent the next two years studying at the Universities of Leipzig, Amsterdam and Stockholm. In 1895 he was appointed Instructor in Physical Chemistry at Johns Hopkins, five years later Associate Professor and in 1904 was made Professor. Professor Jones was Associate Editor of the "Journal de Chimie Physique," "Journal of Franklin Institute" and "Zeitschrift für Physikalische Chemie." He was the author of a number of well-known books on chemistry and translated numerous works on the subject. He was a member of the American Chemical Society.

Charles Albert Davis, noted geologist and one of the foremost authorities on peat in this country, died in Washington, D. C., on Apr. 9. He graduated from Bowdoin College with the degree of bachelor of arts in 1886 and received from that institution the degree of master of arts in 1889. Later he attended the Cornell University School of Forestry and the University of Michigan. During 1886 and 1887 he taught natural science in the Hyde Park (Ill.) high school. From 1887 to 1896 he was Professor of natural science, and from 1896 to 1900 Professor of biology and geology at Alma (Mich.) College. He was Instructor in forestry from 1900 to 1905 and for three years following was Curator of the herbarium at the University of Michigan. In 1907 Professor Davis was appointed Peat Expert for the United States Geological Survey and since 1910 had been engaged in a similar capacity by the

Bureau of Mines. Professor Davis was the author of "Peat in Michigan," "The Use of Peat for Fuel" and several other well-known books and treatises on that subject and contributed to many technical and scientific publications. During 1907 he was editor of the "Journal" of the American Peat Society. He was born at Portsmouth, N. H., in 1861.

Eric M. Gerard, Professor of Electrical Technique of the Montefiore Institute, University of Liege, Belgium, died at Paris on Mar. 27. He was born in Liege in 1856 and lived there until the recent German invasion. He graduated from the University of Liege with the degree of electrical engineer in 1879 and two years later became a member of the faculty of that institution. In 1883, when Senator Montefiore established the institute that bears his name, Professor Gerard was made Director and was the first instructor to teach electrical engineering as a separate subject. For many years Professor Gerard was Inspector General of Telegraphs of Belgium. He was also a writer on technical subjects, some of his best-known works being "Lessons on Electricity and Magnetism," "Electrical Measurements," "Elements of Electrical Technique" and "Electric Traction." For the past 15 years or so he had devoted a considerable amount of attention to processes for plotting curves by photography, on which subject he wrote some hundred pamphlets and brochures. He was a visitor to America as the Belgian Representative to the Electrical Congress at the World's Fair in Chicago and was also a delegate at the Paris Exposition in 1900.

William Edwin Hoyt, M. Am. Soc. C. E., Consulting Engineer of the New York Central Lines, died at his home in Rochester, N. Y., on Apr. 2. He was born in Portsmouth, N. H., in 1845. He prepared for college at Phillips Exeter Academy and after taking the classical college course for a year entered the Massachusetts Institute of Technology, from which be graduated in civil engineering. During his summer vacations he was employed on the Government fortifications which were then being built at the entrance to Portsmouth Harbor. In 1868 Mr. Hoyt began his railroad career by making surveys for the Chicago, Burlington & Quincy R.R. and later had charge of considerable extension work in Iowa and Illinois. He studied European practice in railroad construction, especially in mountainous districts, and finally returned to this country and established himself in Boston as a civil and consulting engineer, where he practiced until about 1880, when he was appointed Chief Engineer of the Buffalo, Rochester & Pittsburgh Ry., in charge of construction and maintenance, which position he held for 20 years. While living in Boston, Mr. Hoyt devoted a part of his time as an instructor in field engineering and bridge and roof construction at the Massachusetts Institute of Technology. In 1900 he entered the service of the New York Central & Hudson River R.R. and the year following went to Mexico to study railway systems. He was sent to the International Railway Congress in Europe in 1905 as an official representative of the New York Central Lines. Mr. Hoyt was Health Commissioner of Rochester from 1892 to 1897.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN CHEMICAL SOCIETY.
Apr. 18-21. Annual meeting at the University of Illinois, Urbana-Champaign. Secy., Charles L. Parsons, Washington, D. C.

NATIONAL ASSOCIATION OF COTTON MANUFACTURERS.
Apr. 26-27. One-hundredth annual meeting in Boston. Office of secretary, 45 Milk St., Boston, Mass.

AMERICAN ELECTROCHEMICAL SOCIETY.
Apr. 27-29. Annual meeting in Washington. Secy., J. W. Richards, Lehigh University, South Bethlehem, Penn.

AIR BRAKE ASSOCIATION.
May 2-5. Convention in Atlanta. Secy., E. M. Nellis, 53 State St., Boston.

CANADIAN RAILWAY CLUB.
May. Annual meeting in Montreal. Secy., James Powell, P. O. Box 7, St. Lambert, near Montreal.

RAILWAY DEVELOPMENT ASSOCIATION.
May 9-11. Annual meeting in New Orleans. Secy., H. O. Hartzell, B. & O. R.R., Baltimore, Md.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 9-11. Annual meeting in Chicago. Secy., Franklin H. Wentworth, 87 Milk St., Boston.

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.
May 10-12. Convention in Pittsburgh. Secy., F. D. Mitchell, 1510 Woolworth Building, New York City.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting at Hotel Sherman, Chicago. Secy., J. G. Crawford, 702 East 51st St., Chicago.

NATIONAL DISTRICT HEATING ASSOCIATION.
May 16-19. Eighth convention in New York City. Secy., D. L. Gasgill, Greenville, Ohio.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
May 17-20. Annual convention in Galveston, Tex. Secy., H. S. Cooper, Slaughter Building, Dallas, Tex.

NATIONAL ELECTRIC LIGHT ASSOCIATION.
May 22-26. Convention in Chicago. Secy., T. C. Martin, 29 W. 39th St., New York City.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Annual meeting in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN IRON AND STEEL INSTITUTE.
May 26-27. General meeting in New York City. Secy., J. T. McCleary, 61 Broadway, New York City.

NATIONAL CONFERENCE ON CITY PLANNING.
June 5-7. Conference in Cleveland. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

AMERICAN WATER-WORKS ASSOCIATION.
June 5-9. Convention in New York City. Secy., J. M. Diven, 47 State St., Troy, N. Y.

SOCIETY OF RAILWAY CLUB SECRETARIES.
June 16-17. Annual meeting in Atlantic City. Secy., H. D. Vought, 95 Liberty St., New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 27-30. Annual meeting in Pittsburgh. Secy., Charles Warren Hunt, 220 West 57th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-July 1. Annual meeting in Atlantic City. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Penn.

Architectural League of New York holds its annual meeting on May 2, at its rooms at 215 West 57th St., New York City. The secretary is Alexander B. Trowbridge.

Illinois Structural Engineers Association has been organized, to be composed of engineers licensed under the new structural-engineers licensing law. President, J. G. Glaver, consulting engineer, Chicago.

Montana Society of Engineers held its twenty-ninth annual meeting, Apr. 6 to 8, in Helena. Inspection trips were made to the East Helena smelter, to the Hauser Lake dam and pumping project and to some mines. The annual banquet was held on Apr. 8.

Traveling Engineers' Association will hold its annual meeting in Chicago, Sept. 5 to 8. Among the subjects to be discussed is "Difficulties Accompanying the Prevention of Dense Black Smoke and Its Relation to the Cost of Fuel and Locomotive Repairs." The secretary is W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

American Association of Engineers announces that it has signed a five-year lease for Suite 601-604 at 29 South LaSalle St., Chicago, Ill., it being the second time in nine months that the new society has enlarged its quarters. It has now a membership of five hundred, 65% of which is in the vicinity of Chicago. The association states that the semimonthly meetings are attended by never less than 100.

Illinois Association of Members of the American Society of Civil Engineers was organized at a meeting in Chicago, on Mar. 27. Meetings are to be held quarterly. The officers are: President, Onward Bates, consulting engineer, Chicago; vice-presidents, C. M. Loweth, Chief Engineer of the Chicago, Milwaukee & St. Paul Ry., and Prof. A. N. Talbot, University of Illinois; secretary and treasurer, E. N. Layfield, Chicago.

National Railway Appliances Association, which conducts the annual exhibition of railway machinery and appliances in connection with the annual meetings of the American Railway Engineering Association, on Mar. 21 elected officers as follows: President, Henry M. Sperry (General Railway Signal Co.), Rochester, N. Y., vice-president, E. H. Bell (Railroad Supply Co.), Chicago; secretary and treasurer, C. W. Kelly (Kelly-Derby Co.), Chicago.

Electric Vehicle Association—This association of persons and concerns interested in promoting the use of electric vehicles, which has existed since 1910, has been affiliated with the National Electric Light Association, becoming the Electric Vehicle Section of the latter. The Electric Vehicle Association had at the time of merger about 1,200 members and 17 local sections. A paid secretary and staff were secured in 1914, and the old organization will be continued.

Southwestern Water-Works Association will hold its fifth annual meeting in Waco, Tex., May 8 to 10. The district covered by the association comprises Texas, Arkansas, Louisiana, Oklahoma, New Mexico, Kansas and Missouri. Among the various papers to be presented are "The History of the Waco Water Plant Under a Water Commission," by Judge W. M. Sleeper; "Efficiency in the Installation and Care of Water Meters," Dwight P. Childs; and "Trend of Modern Water-Purification Methods," C. Arthur Brown. The secretary is E. L. Fulkerson, of Waco.

Grand Rapids Engineering Society was recently organized in Grand Rapids, Mich., and the first regular meeting was held in the Pantlind Hotel on the evening of Mar. 22, following a dinner. The president, W. S. Moore, City Engineer of Grand Rapids, read a paper on "The Paving Problem." The next meeting will be held Apr. 19, the paper being by R. L.

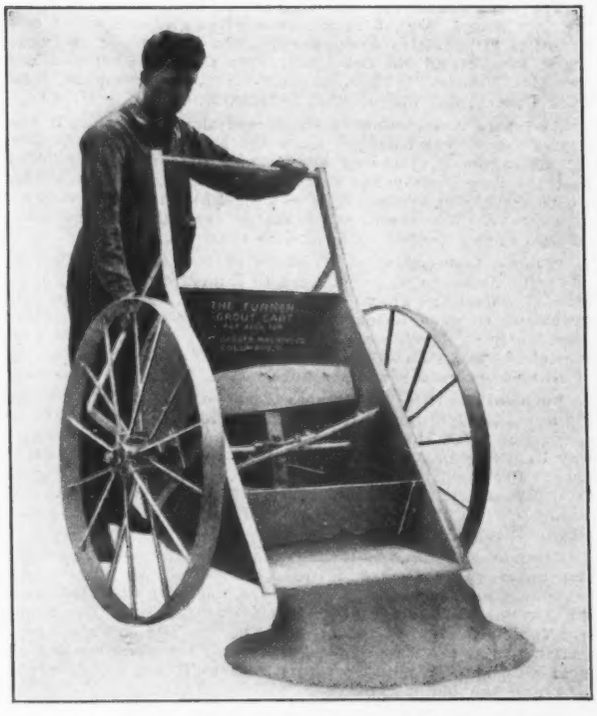
Dewey, on "Vapor Vacuum Heating." The new society is composed primarily of the local members of the Michigan Engineering Society, but it has no official connection with the state organization. The present membership of the local society is 50, and its officers are: President, W. S. Moore; vice-president, R. W. Stoddard; secretary, Walter A. Sperry, Filter Plant, Grand Rapids; Executive Committee, Byron E. Parks and T. C. Roderick.

American Society of Civil Engineers—Full opportunity to voice opposition to the project to move its headquarters to the Enginering Societies' Building was given at the meeting on Apr. 5. Except for a letter of disapproval from R. H. McPherson, the nearest approach to a response was the asking of questions by several members as to the exact meaning of the project. On the other side, President Corthell, Prof. Wm. P. Burr and Clemens Herschel spoke strongly in favor of moving, on the broad grounds of good to the engineering profession. For the same general reason C. W. Hunt, secretary of the society, stated that he should vote for the proposition—in favor of plan A, which involves adding to the height of the building—although from a selfish viewpoint he had rather have the society remain in its present quarters.

Appliances and Materials

Grout Outfit for Pavements

A mixer and cart outfit making grout for pavement joints has been devised by the Jaeger Machine Co., Columbus, Ohio, as a substitute for box and hoe. The mixer is a tilting-drum type of 11-cu.ft. capacity, mounted with a 5-hp. gasoline engine on a steel tractor truck, with loader and water tank.



GROUT CART WITH PADDLES

Each batch is dumped into a Turner tip-cart, shown in the accompanying view, and pushed by one man to wherever needed. The wheel axle goes through the hopper and revolves with the wheels; it carries a paddle frame to keep the grout well mixed.

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Simplified Adding Machine

Knowing that more than half of the nonlisting computing machines sold are intended for use solely for addition, whereas they are designed to perform multiplication, division, square root, etc., the Mechanical Accountant Co., of Providence, R. I., has brought out a simplified machine for adding. The number of keys has been reduced by requiring a so-called "double-touch" operation—pressing the "three" key twice to add six, or pressing "three" and "four" to add seven. Only one size is yet available—for a sum rising to 9,999.99—but larger sizes are being developed.

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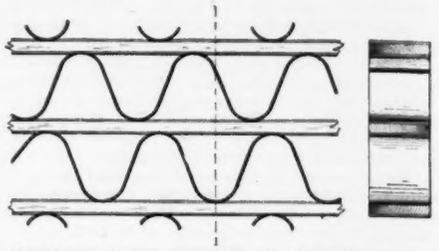
Cellular Sheet Lath

The accompanying sketch shows a new form of sheet lath invented by G. P. Crumbaugh, St. Louis, and now made by the Cellular Lath Co., 5126 North Second St. The particular form was suggested by the difficulty of cleaning mud out of an automobile radiator. For this lath, called the "Keezon," the cell walls are made of fiber-board strips and wood, coated with creosote and damp-resistant preparations. The standard size of a unit is 48x6¾x⅜ in. It is cut and fitted in place



NONMETALLIC CELLULAR SHEET LATH

with a lathers' hatchet. It is claimed that only ¼-in. thickness of plaster is required. No burning is required, and the sheets are applied direct to any flat surface. The flexibility of the sheets adapts them for use on curved surfaces. A 2-in. partition is formed by using ¾-in., or larger, steel channels as studding and weaving the "Keezon" sheets in and out. A general saving of 30% in cost of house partitions is claimed with this material.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

of Engineering News, published weekly at New York, N. Y., for April 1, 1916.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the State and County aforesaid, personally appeared Chester W. Dibble, who, having been duly sworn according to law, deposes and says that he is the Vice-President of Hill Publishing Co., publisher of Engineering News, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are:

Publisher, Hill Publishing Company, 10th Ave. at 36th St., New York, N. Y.
Editor, Charles Whiting Baker, 10th Ave. at 36th St., New York, N. Y.
Managing Editor, Frank C. Wight, 10th Ave. at 36th St., New York, N. Y.
Business Manager, Frederick P. Burt, 10th Ave. at 36th St., New York, N. Y.

2. That the owners are:

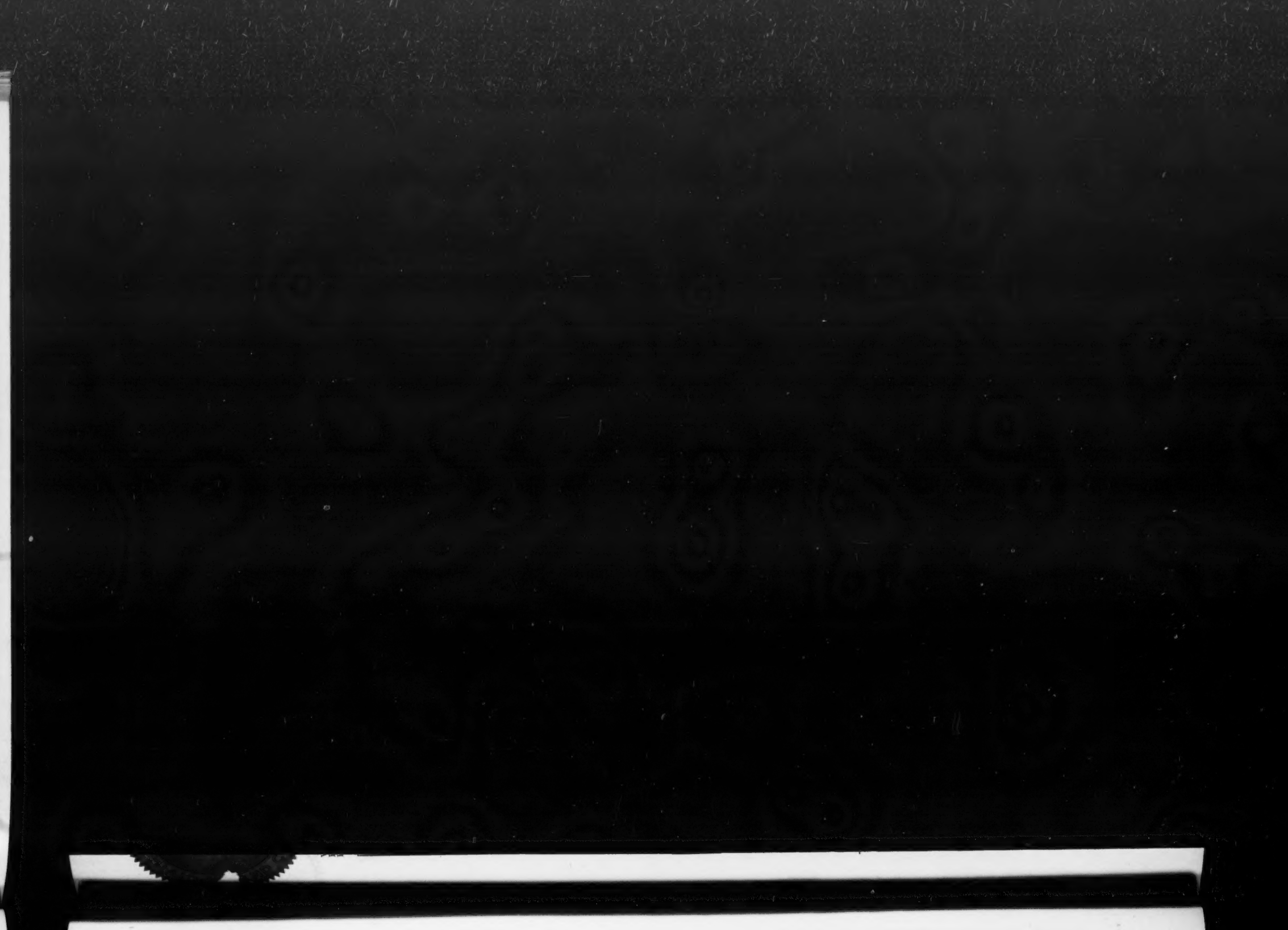
Hill Publishing Company, 10th Ave. at 36th St., New York, N. Y.
Owners of 1% or more of Stock Issued.
Estate of John A. Hill, 10th Ave. at 36th St., New York.
Arthur J. Baldwin, 10th Ave. at 36th St., New York.
Fred R. Low, 10th Ave. at 36th St., New York, N. Y.
John McGhie, 10th Ave. at 36th St., New York, N. Y.
Fred S. Weatherby, 1600 Beacon St., Brookline, Mass.
Frederick A. Halsey, 356 W. 120th St., New York, N. Y.
G. Eugene Sly, 50 Union Sq., New York, N. Y.
Frederick W. Gross, 215 E. 11th St., Erie, Pa.
Alfred E. Kornfeld, 10th Ave. at 36th St., New York, N. Y.
Emma B. Hill, 80 Munn Ave., East Orange, N. J.

The balance of the stock issued (less than 1% each) is owned by 68 employees, 3 ex-employees, and 13 others who are wives, daughters or relatives of employees.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages or other securities are: Mortgage on building, Dime Savings Bank, Brooklyn, N. Y.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

CHESTER W. DIBBLE.
Vice-President Hill Publishing Co.

Sworn to and subscribed before me this 31st day of March, 1916.

[Seal.] RICHARD L. MURPHY.
(My commission expires March 30, 1917.)